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THE STUDY OF GEOGRAPHY

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THE STUDY OF GEOGRAPHY

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J. M. MOGEY

Reading
February 1949

ILLUSTRATIONS

CHAPTER I

INTRODUCTION

ALL sciences depend upon the inquiring mind and one of the fundamental curiosities of man is the desire to know about his neighbours and the type of land they live in. Voyagers down the centuries have tried to satisfy this with tales truthful and otherwise until the very name 'traveller's tale' has come to have a peculiar connotation. The more scientific curiosity of the geographer, whose task it is to survey the world as a physical entity and as a home for mankind, has a long record of useful inquiry. Geography is one of the oldest of the sciences and in the course of its history has sent out many offshoots which have now become independent disciplines; geology, geomorphology, climatology and anthropology are examples.

The parent subject has retained as its special sphere the upper crust of the earth and the lower zone of the atmosphere within which humanity moves. In this wide field of study there must inevitably be some subdivision and to-day two main components are recognized: one, physical geography, concerns itself mainly with the study of the land and water surface and the lower atmosphere; the other, human geography, basing itself on the findings of the physical geographer, considers how the environment affects the life lived by people in different parts of the earth and studies the web of communications which links up separate human groups.

The geographer is thus brought into touch with many different sciences and has his special contribution to make to the progress of knowledge. He takes the facts as furnished by the geologist, the meteorologist, the physicist, and the anthropologist and considers them in the special light of their influence over wide areas of the world and on human society. It is the interaction of land, sea, and air that makes human life possible and the explanation of the distribution of land and sea masses is therefore one of the basic studies of geography. Each element in this complex field is studied in isolation by a separate science. Geography links together these specialist sciences and, using its own methods of study, by maps and diagrams, interprets and rearranges their data in an effort to reduce to order the complicated pattern of surface relief and human activity throughout the world.

'Geography', wrote the anonymous poet, 'is about maps: history is about chaps.' The principal *tool* of the geographer is the map and in fact there can be maps about 'chaps'. Not all maps, however, are good geography. Indeed in one sense no flat map can be good geography. For the earth is a sphere, as near as makes very little difference, and it is impossible truly to represent a curving spherical surface on a flat sheet of paper. Most maps, it is true, do not attempt to represent the whole of the earth's surface at once and the smaller the area to be covered the smaller the potential error. None the less an understanding of the conventions and limitations of maps is an essential beginning to any study of geography.

The map is a social symbol, as is obvious when we consider the fiction expressed in world maps that it is

Fig. 1. MERCATOR'S PROJECTION.
after Cahill, S.G.M. 25 (1909)

possible to see both sides of a sphere at once. It is only possible to draw such outlines by following a set of rules and by believing that a presentation of part of the truth will suffice for certain purposes. All maps are approximations to the truth—in this context, the actual surface of the earth. The departures from strict accuracy in representation may involve changing the shape of the land in order that the relative area may remain constant; showing, for example, a squarish island in a triangular shape but in its correct area. Alternatively the map maker may decide that for certain purposes area is unimportant but that the outline is vital. The most common world-map, known as the Mercator map from its inventor makes this assumption and grossly distorts land areas away from the equator. Thus Java (50,000 sq. miles) on the equator is bigger than Iceland (40,000 sq. miles) in 60° N. latitude but, because of the exaggeration of land areas towards the poles, Iceland appears to be at least three times the size of Java on a Mercator map. If we treat the British Isles as of continental size and plot the outline on this type of map (fig. 1), the distortion towards the north becomes evident.

The framework of any map is built up by drawing representations of the lines of latitude and longitude on the globe. The latitude of any point on the earth's

surface is the distance of that point, measured in degrees, north or south of the equator. The parallels of latitude encircle the earth, the size of the circles becoming progressively smaller as the poles are approached. The pole itself is of course a point. Mathematically it is easy to establish two positions of latitude, the pole and the equator, and it is a simple enough matter with modern instruments to work out the latitude of intermediate places. For the early Greek geographers this was more difficult. Eratosthenes in attempting to measure the circumference of the world, which he knew was a sphere, had to search until he found a place where the sun at noon on the summer solstice (22 June) was vertically overhead. He discovered a deep well near Asswan, Upper Egypt, where the noonday sun on that day cast no shadow on the floor and assumed that this was on the Tropic of Cancer (23½° N. lat.). His calculation of the circumference, despite several faults, was correct to within a few miles. Other Greeks made calculations that were less accurate.

The determination of longitude proved much more troublesome for, as all the meridians are of equal length, there are no fixed starting points. The problem was not solved until the eighteenth century A.D. with the invention of a very accurate clock, called a chronometer. After many conferences, the majority of countries agreed to use the meridian of Greenwich which is called longitude 0°, but the French use the longitude of Paris (2·20° east of Greenwich) as their prime meridian and some other European countries measure from an imaginary place, Ferro, 20° W. of Paris. The determination of longitude depends on the fact that the earth makes one complete revolution on its axis in 24 hours

and that the highest point reached by the sun at any place is midday by local time. Thus midday at Greenwich occurs approximately five hours before midday at New York and about five hours after midday at Delhi. As the earth turns from west to east through 15° in one

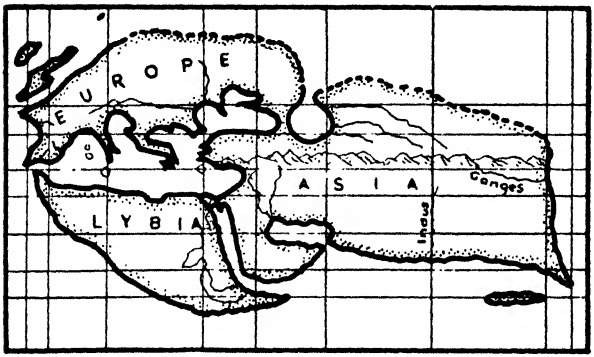

Fig. 2. WORLD ACCORDING TO ERATOSTHENES.
after Raisz

hour (360° in 24 hours), the variation in time shows that New York is 75° of longitude west of Greenwich and Delhi is 75° east of Greenwich.

The representation of the lines of latitude and longitude on a flat sheet of paper forms what is known as the *graticule* of the map. Mercator, to return to our original example, so arranged his map that the graticule is composed of straight lines crossing each other at right angles. The exaggeration towards the poles, referred to above, arises from this method of construction, for the small circles of latitude are all drawn equal in length to the equator; while the poles, which are points on the globe, would become the same length if they could be drawn.

But Mercator increased his north-south distances along the meridians in the same proportions as his east-west distances so that the poles are at an *infinite* distance from the equator and for that very good reason they can never be shown.

Although it is not entirely in accordance with strict mathematical procedure, the best way to visualize the construction of such graticules as Mercator's is to imagine the globe enveloped in a cylinder of paper. If this cylinder touches the earth along the line of the equator this is the one line on the map that will be exactly the same length as on the model. A light in the centre of the globe will throw the shadows of the lines of latitude and longitude on to the paper cylinder but will greatly exaggerate their scales. Most maps constructed on this principle, that is to say based on cylindrical projections, employ some method of modifying the graticule.

The cylinder is only one of the types of figure that can be fitted approximately to the sphere and then spread out to form a flat surface. Another great class of projections is derived from the cone, which can touch the earth along a line of latitude and thus, as in the simple cylindrical projection, have one line true to scale on the map. Conical projections are mostly used for small sections of the earth, such as a single country. They have been used more frequently than the cylindricals and consequently even more variations exist. A common development is the map in which each parallel is drawn true to scale; this can be visualized as made up of parts of a series of cones each of which touch the earth on a different line of latitude. The great international map of the world on a scale of 1: one million (i.e. one inch in the map equals 1,000,000 inches on the ground or 16 miles

approximately) is constructed on one of these modified conical projections. On these beautiful maps the line of the top of the map and of the bottom are both lines of latitude, true to scale. The east and west margins are lines of longitude, also true to scale. In this way the four bordering sheets can be fitted to the central one for any part of the world with a minimum of distortion.

All these groups of maps have special methods of construction and by slight variations may be made equal-area or good-shape maps as desired. Zenithal maps form the third great class. In these the net-work or graticule of latitude and longitude is transferred to a flat sheet of paper which touches the globe at one point. The zenithals are likely to become particularly important in this age of air travel for, despite Euclid, the shortest distance between two points on the surface of the earth is a curve, that part of the circumference of the circle joining the two points which has as its centre the centre of the earth. In certain of the zenithals this 'great circle' distance becomes a straight line and in air travel it is the 'great circle' distance that counts. In the past Mercator, a map designed for sea travel, has had most attention. In this map a line joining any two points on the earth's surface, say the Scilly Isles and Panama, crosses the graticule at a constant angle. A ship sailing this course will eventually, if proper allowance is made for drift due to winds and ocean currents, arrive at its destination. Such a line, known as a rhumb line, is by no means the shortest way. A great circle course from Scilly to Panama, to take the same example, departs by hundreds of miles from the Mercator compass course. On the Mercator projection this route looks very much longer because that map sacrifices everything to the

rhumb line. A zenithal projection centred on south-west England would show all places on the great circle routes on the same straight line. In its turn, of course, this zenithal projection disguises the fact that, in order to follow the straight line, constant changes in compass bearings must be made (fig. 3). Which is really only

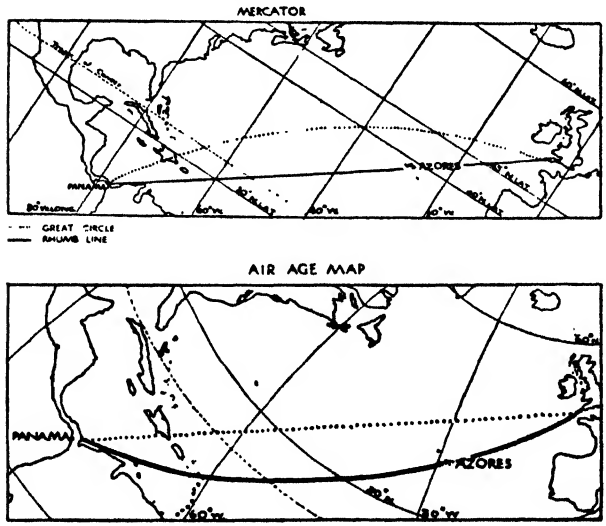

Fig. 3. RHUMB LINE AND GREAT CIRCLE ROUTES, SCILLY TO PANAMA.

another way of saying that only on a sphere is there a true indication of the shape, direction, and distance apart of places on the earth.

To the geographer the construction of maps is a most interesting subject, involving only a knowledge of simple mathematics and a certain amount of computing. For

those who possess a knowledge of trigonometry a study of the books on the subject which are recommended in the book list at the end of this volume will be well rewarded.

It is not necessary, however, to know the mathematical details of map construction before gaining an appreciation of geography but it is vital that there should be a knowledge of the limitations of the map. We have mentioned some of the qualifications that must be borne in mind and it should be remembered that the errors which can be introduced depend on the scale of the map. Maps of the whole world, of continents, of a country, when reduced in size to fit within the compass of an atlas or of such a book as this, need to be interpreted with care. Roads, rivers, towns must be represented by symbols out of all proportion to the size of the feature. The most truthful representations of the earth's surface are the large-scale topographic maps, such as the one inch to the mile Ordnance Survey map of Great Britain. Even on this scale a main road is usually marked as 1/10th inch wide, which is a great exaggeration, for 1/10th inch should represent 176 yards, whereas few roads are more than 10 yards across. Maps of smaller areas, which show field boundaries and acreages are drawn to an even higher degree of accuracy but they are often of more value to the surveyor than to the geographer.

We have emphasized that the map is a social product. The techniques required for its construction developed rather late in human history. There have, it is true, been maps of a sort from Babylonian times, but they served mostly to delineate field boundaries as did the estate maps of eighteenth-century England. Some early thinkers

even aspired to a representation of the world, but until the nineteenth century their vision outran their competence. Long before that the mathematicians had worked out beautiful but complicated formulae for the representation on a plane surface of information gathered on a sphere; but engineers and other field workers had not the equipment needed to make exact measurements. The name given to our topographic maps, Ordnance Survey maps, shows that the detailed representation of the countryside had to await not only the development of surveying equipment but also the need for accurate maps. It was the artillery that first required them, to plot the results of the new field pieces, which had a disconcerting habit of extending their range and power just when wars had to be fought in new terrain, e.g. in India and North America. To fulfil this purpose the exact topographic survey of Great Britain was begun in 1791.

In closely settled areas the topographic maps provide a wealth of detail. As a scientific generalization the modern map has no equal. It conveys the maximum of information with the minimum of fuss. The results of the labours of the surveyor, the engineer, the archaeologist, and the historian appear on it as well as those of the geographer. Over most of the land surface of the earth this work is by no means complete. Explorers are still required and it is they alone who can bring back material from uncharted country. While few large tracts of virgin country remain, the modern explorer can do much to answer problems at present known only by inference.

It is a relatively simple matter to make reconnaissance maps of new territory or to fill in additional detail in

lands where the outlines are known. No one need be discouraged by the accuracy achieved by the Ordnance Survey. With a standard prismatic compass and a pocket barometer quite elaborate charts can be constructed. Their accuracy will be sufficient when due allowance is made for reduction in drawing. Notebook maps of routes require some indication of direction which the compass will give. In this country the presence of buried pipes, of iron gateposts and so on makes for inaccuracy in compass readings. Objects off the line of march like a mountain peak or a mill chimney can be plotted by observing their compass bearing at the beginning of the route and again from a convenient sighting point later on. In theory when the map is drawn the two lines at the correct bearings from these positions in the plan should cross on the exact spot of the peak or chimney. This often happens in practice as well.

The second problem in map making is the measurement of distance. Some explorers push a bicycle wheel with a mechanical counter, a method which has both its advantages and its drawbacks. For short distances pacing can be quite effective; and for long marches, if a steady pace is maintained at say 3 miles per hour, the times of starting and stopping give a sufficiently reliable indication. The measurement of distance is too familiar to require elaboration. The size of the paper and the distance traversed will determine the scale on which the final drawing may be made. This scale reduction will compensate for some of the errors due to the use of rough and ready field methods.

Only in the preparation of maps which show heights and hollows will the pocket barometer be consulted. The barometer falls approximately 1 inch for every 900 feet

climbed above sea level and by constant readings relative heights may be obtained. Variations in barometric pressure at sea level in these islands mean that this method of height reckoning is not very satisfactory, but in some other parts of the world it can be useful.

This digression is intended largely to assure the reader that making maps is not a great mystery, closed to all who have not had a long and tedious training. Valuable maps can be obtained by very simple means and with a little practice in route traverses of the type outlined above anyone may progress to the use of the plane table and the construction of highly accurate and detailed maps of local areas. A good map extends our knowledge of the habitable globe more than dozens of descriptive accounts.

The expansion of geography from the study of the *known world* of the Greeks, as shown in fig. 2, to that of the whole surface of the globe has followed upon the progress of exploration from the late fifteenth century to the present day. The exploration of the world really began when Europeans equipped with plank-built sailing ships, the compass, and an insatiable craving for spices, set out on the stormy Atlantic in an endeavour to circumnavigate the continent of Africa. Each nation state, as it set its internal affairs in order, turned to the sea for an outlet and, in turn, Portuguese, Spaniards, Frenchmen, Netherlanders, and British, penetrated to all parts of the globe that could be reached by sea.

Let us look at the atlas briefly and see the parts most accessible to ocean voyagers. It was fortunate that the explorers first set out on the North Atlantic ocean for, as we see, into that ocean flow several of the world's largest rivers. Bays and minor seas penetrate deeply into

Europe and America. As a geographer I would suggest that we state this the other way round, i.e. that the bays and seas of Europe encouraged seamen and because of this they ventured forth on the ocean. Into the Atlantic flow waters from more than half of the earth's surface. Though at first the sailors regarded the continents of Africa and the Americas as barriers on the way to India and the Spice Islands, their existence has become more and more important. The St. Lawrence and Mississippi allowed the French to make a brilliant pioneering survey of the interior of North America at a time when the English colonists had not yet thrust their way across the Appalachians. On the other hand the exploration of Africa was not completed until the latter part of the nineteenth century, largely because Africa consists of high plateaux, with the rivers tumbling over the edges in rapids or falls, and no easy route was available to the interior.

The period 1850–1914 saw the end of the exploratory stage over most of the world. There are still a few isolated mountain ranges in south-east and north-east Asia and the continent of Antarctica which are known only from reconnaissance surveys. While we know the framework and have many facts about the surface, the world is still far from adequately mapped. Outside Europe and European settlements in the temperate lands abroad, maps on a scale of less than 1: one million are either lacking or only approximately accurate.

It was in the period 1850–1914, too, that geographers, buried under a mass of new discoveries since 1492, emerged into the light of day with something more than a list of mountain peaks, capes, bays, principal towns, and so on. The gazetteer type of geography was still

common in 1914 but since that time it has given way to the more scientific conception. The spread of the new geography has, of course, been subject to the same controls of distance and time-lag as other phenomena, and I have no doubt that gazetteer geographers are still teaching in outlying parts of the world: indeed I met with one in western Ireland as late as 1942.

The pioneer workers in the analysis of geographic facts included Humboldt and Ritter, both of whom emerged in the period before 1850. Humboldt, a great traveller and a shrewd observer, studied the lands of Central and South America and described from his studies of the Andes the pattern of successive zones of vegetation and settlement on the mountain sides. This interest in associations, in the interrelationships between plant, animal, and human life and the landscape is the hallmark of a geographic mind. Ritter, a more academic figure, studied the reports of other travellers and writers, and brought forward the concept, which was quite novel at the time, that the earth is a physical unit made up of interrelated parts. From this standpoint geographers have contributed much to the study of land-forms in the new science of geomorphology.

The publication of Darwin's book *The Origin of Species* (1859) gave a new emphasis to the study of life on the earth. The idea of time was then added to purely spatial study. If physical geography stems from geology and physics, human geography developed side by side with the study of plant, animal, and human life, revitalized by the theory of evolution.

The binding thread of the studies of both the physical and the human geographer is the *region*. Herbertson, in England, developed the notion of the 'natural region',

that is large areas of the world over which climate, soils, and natural vegetation are much the same; for example the 'rain forests' on either side of the equator or the hot deserts. This gave a truly geographic frame within which to weave together the varied strands contributed by the independent sciences which studied the environment of man.

Human geography, with which the later chapters of this book deal, begins with this concept of the natural region. Studying the relations between the environment and man, it seems natural that two major schools of thought have developed. One, as represented by Ratzel, Demolins, E. C. Semple, and Griffith Taylor, lays stress on the domination of man by his environment, and some disciples of this school have even gone so far as to suggest that if history were to begin again the same processes would inevitably be repeated in the same localities. This extreme simplification may not do full justice to this school of thought but in greater or less degree it underlies much of their thinking.

The second school of human geography, which is now the dominant one, holds that the environment presents to man certain opportunities: the emphasis is on the creative power of human groups to modify the landscape and, within certain broad limits, to evolve their own society. The most important name connected with this group of geographers is Paul Vidal de la Blache and the name given to their philosophy, *possibilism*, as opposed to the geographical *determinism* of the former writers, derives from a work of the historian, Lefebre. With the development of studies of human society in the past fifty years the outstanding fact has emerged that man is a social being, and the study of human society in diverse

environments has shown how much the demands of the human group affect its relation to the environment. One has only to think of the demands on the same landscape made by the aboriginal inhabitants and by the British settlers in Australia to realize how important this social aspect can be. Yet the same European stock settled in Canada evolved a different landscape pattern so that we must study both the society and the environment.

For such a wide subject it will be obvious that this book can do little more than whet the appetite and point the way to further reading and thus the book list is an integral part of the work. It will be found, too, that the examples given are much more easily followed if the reader keeps an atlas by him as he reads.

CHAPTER II

MAJOR LAND FORMS

BEFORE we allow our attention to be distracted by the entry of man upon the scene, we can seize this opportunity to examine the nature of the setting in which he is to perform. In this first glance we must include both the distribution of land and water and the variants in form of the land surface whether plain, plateau, or mountain peak.

The world-map shows that land and water are very unequally divided. There is obviously much more water than land; indeed, so far as is known, less than 30 per cent. of the entire surface is above the ocean. The water surface is continuous but the land is broken up into many pieces. The larger land-masses lack a conventional name. Thus the single block of land that stretches from the Arctic Circle to the Cape of Good Hope and from France to Kamchatka has been divided by custom into three continents, Europe, Asia, and Africa. Physically it is only the largest island in the world ocean. Beyond it lie the Americas and Australia, the other significantly large pieces of land. We notice too that nearly all the land lies in the northern hemisphere, locked tightly around the Arctic ocean. In the southern hemisphere less than one-fifth of the surface is land. The southern continents taper southwards and a certain balance is shown by the unexplored continent of Antarctica around the South Pole, compensating for the ocean at the North Pole.

For an answer to the problem set by the distribution

of land and sea we must turn to the geologists and the experts in geodesy or earth measurement. The problem, however, is too big to expect unanimity. One theory sets off from the fact that the earth is not a perfect sphere; the polar diameter is some 27 miles shorter than the equatorial. Of all types of solid a sphere has *least* surface area for a given volume. On the assumption that the earth is cooling down and was once a perfect sphere, some scientists hold that it is now tending towards a shape that has *most* surface area in relation to volume, a shape rather like two pyramids joined together at the base, known as a tetrahedron. This theory helps to explain the triangular nature of the continents but it does not account for the greater area of the oceans. In any event a tetrahedron is never a final stage in the cooling of matter and presumably would give place to yet another spheroid of smaller dimensions.

Amongst the many suggestions put forward to account for the distribution of land and sea, possibly the most widely accepted is that which regards the true crust of the earth as the ocean floors. Above this the continents are supposed to rise in uneasy equilibrium like rafts above a water surface. The actual difference between the highest and lowest points, some 60,000 feet between the summit of Everest and the bottom of the Guam Deep, would appear to scale on a globe of 10 inches diameter as approximately 1/100th inch, so that in terms of measurement the analogy of the raft is apt enough. The little evidence we have of the rocks at the floor of the oceans also tends to support this theory, for those discovered are rather more dense than the average of the continental rocks. Furthermore, if the deep-seated continental rafts are in a state of imperfect

equilibrium, we have an explanation of the known fact of geological history that the sea has often invaded the land. Such movements occur very slowly, but geological time is an ample expanse where sudden events may in fact take thousands of years.

In 1912 Wegener, after a close study of climates in the past and of the present distribution of plants and animals, put forward the revolutionary suggestion that the Americas had drifted off from the Old World at some point in time. He pointed out that the great bulge of Brazil would fit into the Guinea coastal bay of Africa, that the east coast of North America shows a rough parallelism to the Atlantic coast of Europe and that many similarities of mountain form can best be explained by assuming that America and the Old World were once united. This idea of horizontal movement, as opposed to the up and down movement mentioned in the last paragraph, has aroused vigorous opposition, principally on the ground that the force required to move a continent is beyond our knowledge. The theory of Wegener is most attractive but the verdict for the present must be the cautious 'not proven'.

This discussion of fundamentals has had to be too brief to do justice to the tremendous amount of painstaking collecting of fact and exactitude of measurement that have preceded the attempts at explanation outlined here.[1] Here we as geographers are trying to explain the distribution of the land-masses and it must be admitted that the explanation of the surface pattern of land and water on the globe is not yet known. The fact

[1] The companion volume *Geology* in the Home University Library includes a discussion of these theories in relation to the origin of rock masses.

that there is a pattern and that a theory which will fit all the facts will one day be evolved is not in doubt.

It is possible to arrive at more satisfactory conclusions about the distribution of the surface features of the continents. We shall see that the mountain ranges form patterns, often vague and half obliterated, and in order to understand these patterns we must give some account of the origin of the most widespread type, the folded mountains. On the earth we saw the continents as triangular masses raised above the general level of the sea. Once any land is elevated above sea level, wind and wave and weather all begin to work upon the surface, giving it its own individuality. Geographers call this wearing down of the land *erosion* and by this process, if continued sufficiently long and without interruption, the land surface would be reduced to a rolling plain not much above sea level, called a peneplain.

Most of the material worn off the land is carried by rivers and deposited under the sea; here it is laid down in zones, the coarser material inshore, finer sands further out and fine muds beyond that again. On the floor of the sea in clear water the bleached bones and shells of myriads of tiny sea creatures pile up and form such rocks as chalk. In muddier water the same material might form the blue-grey mountain limestone of the Pennines or central Ireland. All these rocks, sandstones or grits, mudstones or shales, chalk, limestone, etc., are called sedimentary rocks and they are normally laid down in beds or layers one on top of the other. Now it will be obvious that if two such rock layers exist, the bottom one must have been laid down first; and so, in a series of undisturbed beds, the oldest occur at the foot and there are gradations of age, which can sometimes

be measured by the thickness of the beds, until the topmost strata are reached. Geologists who study this sort of evidence have thus a rough and ready method of calculating the age of the land surface of the earth.

They have shown that some parts of the land have been exposed to the air from the earliest times of which we have any record. Other portions of the earth have moved up and down many times, as shown by the variety and age of the beds now at the surface. As might be expected from what was said above about erosion, these veteran lands should naturally form low peneplains and the majority do, but others have been re-elevated into plateaux in comparatively recent times, i.e. recent in comparison with their age which may be 1,000,000,000 years. These stable blocks are shaded in fig. 4 and are found in north Canada, north Europe, and Siberia: in the southern hemisphere stable areas at a higher elevation occupy much of the eastern bulge of South America, most of Africa, the peninsula of India, and western Australia.

Throughout the long geological history of the Earth there has generally been little disturbance of the surface and rivers, rain, wind, and ice could proceed at will with their work of erosion. In contrast to this normality, on at least four widely separated occasions great earth storms have swept the planet: the beds of rock on the sea floor have been twisted and bent and forced up into high mountains. We see to-day the strata which were originally horizontal or nearly so, contorted into fantastic shapes. In all these tremendous upheavals the old stable masses, or shields, remained firm and the mountain-building movements piled up the contorted strata, folded into ridges and valleys, against them. That is

why a knowledge of the shields of the world is necessary to an understanding of the trend of the folded mountain systems.

Little now remains of the earliest of these mountain systems. Worn down to sea level, re-elevated and worn down again several times throughout the ages, only a few uncertain remnants survive. The first reasonably complete mountain system is known as the Caledonian, since the re-elevated ranges now form the Highlands of Scotland. In Europe the signs of this disturbance follow a great arc from Greenland to North Cape; mountains formed at this time extend in a NE.–SW. direction from North Cape to Clew Bay in Ireland. The Caernarvonshire peninsula of Wales and the Wicklow Hills of Ireland also follow this trend-line. Mountain building dated as Caledonian can be deciphered upon all the continents; the direction and amount of the folding varied, but, in general outside Europe, these mountains are not of especial importance to the geographer.

At the end of a long period of quiescence, during which new limestones and the coal beds were laid down, a second period of mountain building took place. In Europe the mountains formed at this time are known by many names to the geologists; taking our cue from Professor H. H. Read we shall use the term Hercynian to refer to the complex. These mountains, now no longer a continuous system, run across Europe from west to east. Folding of this age determines the direction of the long inlets of south-west Ireland, of the south coast of the Bristol Channel, and of the peninsula of Kent; examples from the mainland of Europe are the Ardennes, the Harz (whence Hercynian), the Erz and Reisen Gebirge, and the platform of low hills that forms the

northern edge of the Carpathians. A cross fold, at right angles to the main trend-line, is responsible for the Pennines which form the backbone of England. If we have this system firmly in mind the location of the major coalfields of Europe is a simple matter: the more important fields lie along the northern flank, in South Wales, in France, Belgium and Holland, in the Ruhr of Germany, in Saxony, Silesia, and far to the east in the Donetz valley of south Russia. In America the Appalachian mountains, formed of sediments laid down in a great trough-like sea, are for the most part comparable in age to the Hercynian mountains of Europe. We find that, as in Europe, the richest coalfields occur on their flanks in Pennsylvania, West Virginia, and Alabama.

The last and most recent earth revolution has given us the highest and most continuous mountain ranges in the world to-day. This is not because it was more violent than the preceding ones but simply because the forces of erosion have not yet had time to bring about much reduction in the height of the peaks or the extent of the ranges. We call it the Alpine revolution, and the ranges associated with it run across the south of Europe from the Pyrenees to the Caucasus. The ranges run parallel for the most part, but at two or three places they have coalesced to form a complex upland region called a *knot*. Switzerland lies on the fringes of the Alpine knot. From this, ranges spread out—as for example the mountain lines of the Apennines, which are continued through Sicily and the Atlas mountains of North Africa. The sequence is briefly broken at the Straits of Gibraltar and extends as far as the Sierra Nevada of Spain. In the north of Spain the mountain chain of the Pyrenees once

continued to meet the Alps. To the east of Switzerland two main chains diverge; the Carpathians sweep in a great arc enclosing the plain of Hungary, while the Dinaric mountain ridges form the backbone of Yugoslavia and Greece. The Dinarics are drowned at the edges on the Adriatic sea and southwards they dip under the Mediterranean to reappear in Crete. Extensions of both the Carpathians and the Dinarics traverse Turkey and unite with the Caucasus to form the Anatolian knot. Mountain arcs from this sweep round the southern end of the Caspian and southeastwards along the flanks of the Tigris-Euphrates valley to join again in the complex of high mountains in north-west India, known as the Pamir knot. The Alpine folds do not stop there; they continue eastwards as the great wall of the Himalayas which, on meeting the western outposts of the old stable hill mass in southeast China, break southwards in the many folded ridges of Burma and Malaya to the East Indies. Mountains of the same age form the backbone of Japan and continue northward as the island arcs of eastern Asia where they link up with the outposts of the American systems in the Aleutians. The magnificent mountain ranges of the western cordillera in Canada and the U.S.A. with their continuations in Central America and in the Andes of South America exhibit the same type of succession, single arcs coming together to form knots at intervals. These mountains are the result of recent folding that is not quite contemporaneous with the Alpine revolution in Europe. Only the latest phases which thrust up the Coast Range coincide in date with the Alpine of Eurasia.

Associated with the Alpine storm are many other physical features of the earth's surface. The mountain

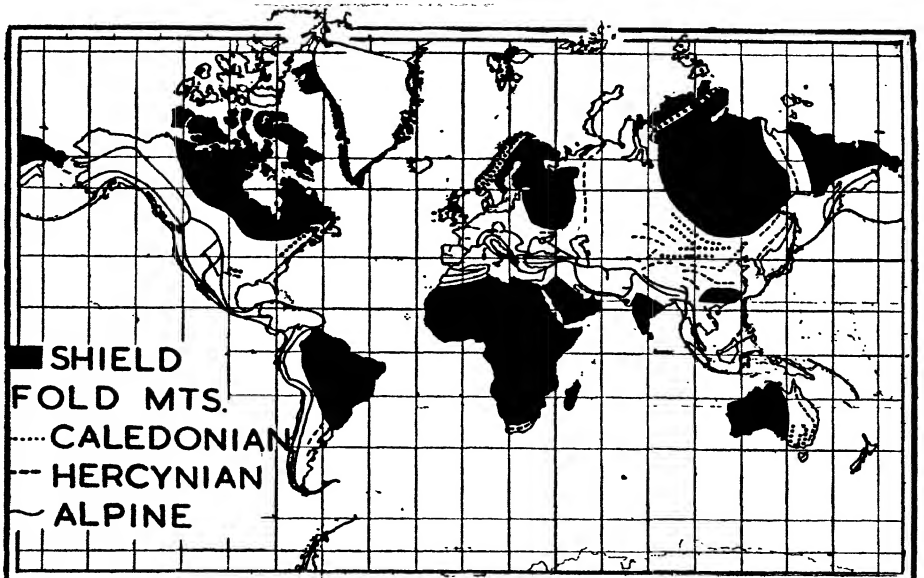

Fig. 4. FOLDED MOUNTAINS.

arcs in their elevation drew with them large tracts of the older rocks: the Meseta of Spain, the plateau of Tibet, the intermont plateaux of the U.S.A., and the Bolivian highland are examples. Occasionally these old blocks were shattered by the strain of uplift and so we get such mountain-girt depressions as the plain of Hungary and the basins of the Mediterranean Sea. That the direction of the folds is controlled by old stable masses outside the mountain arcs can be seen not only from the eastern Himalayas but also in North America, where the increase in width of the mountain zone is clearly evident south of the Great Lakes once the control of the Canadian Shield is relaxed.

Several land-forms of lesser magnitude stem from the shields and the folded mountains. A moment's reflection will show that a compensating trough or valley must follow the edge of these major earth features. The rim of the Canadian shield is marked by a line of lakes, Great Bear, Great Slave, Lake Winnipeg, the five Great Lakes (Huron, Michigan, Superior, Erie, and Ontario), and the St. Lawrence valley. The gulfs of Bothnia and Finland together with Lakes Ladoga and Onega mark the edge of the Baltic shield. Trough valleys lying below the outer folds of the Alpine system are numerous: the Rhône, the Po, the Tigris, the Indus-Ganges-Brahmaputra depression, are all of this type and a study of the atlas will indicate many others.

Although the tremendous forces which uplifted the mountains are not yet fully understood, the effects are evident. Their action upsets the stability of the continental rafts. To balance the great mountain piles, a wide underground zone, like the root system which supports a tree, must exist. We have evidence that at the

base of the mountain ranges molten rocks such as granite are extruded from deep layers in the crust. This type of rock occasionally forced its way up in a molten state to form volcanoes and lava flows, and the interruption of the stable equilibrium of the earth often manifests itself by earthquakes. For example, the mountains of western America from Chile to Alaska have many active volcanoes, and the most severe earthquakes have a habit of frequenting these folds whether it be at San Francisco, Tokio, or Turkey. Older mountain building, too, was accompanied by the same phenomena and on the outer perimeter of the shields much volcanic activity has taken place in the past. Such disturbances are attested by mineralized beds and these old rocks, poor in soils, have produced rich mining areas; nickel at Sudbury (Canada), and near Petsamo (Finland), gold in South Africa and West Australia, tin in Bolivia, all exemplify the general principle.

Deep sub-continental roots holding aloft the mountain ranges, volcanoes and the movement of molten rocks underground, are all phenomena on a world scale. The interpretation of the mysteries of their formation is properly the field of the geologist. The geographer can help and has helped by attempting to apply principles worked out in local field-studies to other areas of the world, by the discovery of anomalies and new problems, and by plotting distributions on a map which shows up correlations or demonstrates the lack of agreement. The greatest contribution of geographers to the study of the physical features of the earth's surface has been in the examination of the minor features of the landscape. Unobsessed by origins, they have progressed from a classification of different types of terrain, plain,

mountain, plateau, valley, &c., to a dynamic conception of weathering under different climatic cycles.

Attention has been concentrated on the river basin and on the hills separating the catchment area of one river from the next. The wearing down of the land to the complicated surface levels that we see to-day has been the collective result of the agents of erosion. The most important of these is running water, whether in the form of rain, subsurface water, or rivers. Each river cuts its own valley, using pebbles, sand, and finer particles to wear away its bed. The work it does is in direct proportion to the volume of water and the speed at which it flows. Thus it is most effective in wearing away its bed in the upper parts of its course after heavy rain. The valley sides tend to be undercut and to be washed down by rain so that they slope evenly to the stream giving a V-shaped cross section to the valley. As the greatest cutting action takes place in the upper section of streams they tend to push their headstreams back over a period of time and occasionally one stream will *capture* the headwaters of the less vigorous stream, by deepening its valley more rapidly than its neighbour. Such quick erosion is commonly associated with the presence of beds of rock softer than the normal for an area. The Yorkshire Ouse, working backwards in the soft rocks of the Vale of York, has captured the tributaries of a river that formerly flowed to the sea at Flamborough Head. The characteristic of river capture is the presence of an 'elbow' turn in the stream at the point of capture; one of the best examples in England is the turn of the Witham at Lincoln.

In a damp climate the collective action of all the streams, reinforced by raindrops, erodes the whole

surface of the landscape in a uniform manner and, as we have said before, the end result is a peneplain. To reach this condition requires a very long period of absolute stability in the relations of land and sea, for obviously if the sea level drops (or the land rises, which has the same effect) rivers will have a steeper gradient and will recommence to cut away at their beds in a vigorous manner. In a world which has emerged comparatively recently from an earth revolution there are few fully developed peneplains, although good examples may be found in the U.S.S.R.

In deserts or where rivers flow across arid plateaux the banks are not worn away to the same extent as in moister lands. The raindrops and the mantle of soil are wanting. The river, however, as it flows along continues to cut down into its own floor and so instead of a V-shaped valley we get steep-sided canyons. The Grand Canyon of the Colorado river is the most magnificent of these; its great depth is due entirely to the cutting action of the Colorado river but this action has been continuously rejuvenated by the slow uprising of the land surface.

In mountains or on the plateaux, then, rivers are actively engaged in wearing away the surface of the earth. The section of a river in the hills is called the youthful section, and rapids, waterfalls, and steep V-valleys are all signs of youth. So too are lakes, for in the nature of things they get filled up with the sand and mud transported by a river which upon entering a body of still water has the speed of its flow suddenly decreased and can no longer carry a load of sediment. The outlet, too, is constantly being worn away and the level of the water lowered so that inevitably lakes are temporary features of the landscape.

Similarly the carrying power of rivers is diminished at the foot of the hills and in this section of their courses, the mature section, rivers are building up land by the deposition of sediment. Thus along the southern slopes of the Himalayas there is first a zone of stones and boulders dropped by the rivers as they slacken speed on reaching the plain, forming an infertile jungle strip known as the *terai*, and then a fertile, stoneless alluvial plain which stretches for hundreds of miles. In time the building-up action of a river becomes as important as its wearing-down action and together, of course, they reduce the average height of the land.

Great rivers have built up wide stretches of fertile soil in their lower courses. These are known as flood plains because they are little above water level of the streams and subject to floods from time to time. On these unconsolidated sediments the river, deflected by minor obstacles, swings about freely in 'meandering' curves. Flood waters, increasing by their volume the rate of flow, often cannot take time to round all the bends and straighten up the river channel, leaving the former bends as temporary lakes or swampy depressions in the midst of the flood plain. These flood plains because of their great fertility and their easily worked soils are very desirable places for farming. The control of the river is the principal difficulty. By building earthen banks or levees it may be confined within its channel but then, deprived of the opportunity to drop its load of mud on the flood plain, the river deposits it in its own bed and the levees have constantly to be raised. After some decades the bottom of the river channel may even run above the level of the plain in sections, a condition of some delicacy. Great floods

can ensue when levees such as this are broken, for once free the river may carve for itself a new channel elsewhere on the gently sloping flood plain. The Hwangho (China's Sorrow) did this in 1852, ploughing a new valley through field, farmstead, and town and moving its outlet to the sea by some 300 miles, from the southern to the northern side of the Shantung peninsula. The flood plains and the rivers in these islands are much smaller and we are not so crowded on the land as the Chinese, but more or less severe flooding is endemic to the lower courses of our streams.

Some flood plains have been built on land originally planed away by rivers, but others have been built up as additions to the land surface. When a river carrying a load of sediment enters a tideless sea or a lake it deposits its burden and in time the accumulation forms what is known as a delta. This new land is often fan-shaped and is nearly always only slightly above the level of the sea or lake, but in the course of centuries it can be built up so as to be out of danger of flooding. Former deltaic deposits which now form extensive plains are those of Lombardy, where Ravenna, a Roman naval port, is now ten miles from the sea, and the Tigris-Euphrates where, within the period of written history, these two streams once entered the sea by separate mouths, whereas now the joint stream, the Shatt-al-Arab, is 123 miles long. The Rhine-Maas delta, which includes most of Holland and part of Belgium, has been formed in a strongly tidal sea but at a point where two tidal currents meet offshore and neutralize each other.

We have referred earlier to the collective action of all the streams in a region, and before we leave this subject a word must be said on the types of rivers that can

exist. Imagine a piece of land composed of alternating beds of hard and soft rocks, which has just emerged from the sea. The first rains will flow in parallel channels directly to the sea and the stream valleys so formed are classified as *consequent*. As erosion proceeds tributary streams join these original rivers from right and left. These *subsequent* streams usually excavate their valleys in the softer rock strata. In time such a union of streams will form a pattern on the map rather like a tree trained against the wall, a trellis pattern. The rivers of the Weald of south-east England have developed in this fashion on either side of the original anticlinal land surface. The consequent streams have maintained their original valleys by cutting gorges through the North and South Downs at the same rate as their sources removed the chalk highland that formerly covered the Forest Ridges. There have been a number of instances of river capture and some routeways through the Downs are now no longer occupied by rivers. More typical is the water gap with its bridge and market town to collect trade and travellers from both sides of the hills, such as Guildford, Dorking, Lewes, or Canterbury.

Although rivers are most effective agents in wearing down the land, other forces are at work. In dry lands without running water the alternation of heat and cold from day to night eventually splits up the rocks. The different mineral crystals comprising the rock expand and contract at different rates, and their pressure after a time breaks down the surface. Water in deep cracks, frozen at regular intervals, also exerts a considerable strain and may force large fragments away from the parent rock mass. In the deserts this rock waste accumulates as an untidy apron at the foot of the hills and fills

up the valleys that have been cut by occasional thundershowers of the cloudburst type. Under temperate conditions this material would lose its angular appearance and be carried by rivers towards the sea. Here in the waterless lands the wind is the principal mover and it can transport only the smaller particles. These sand grains pile up as moving dunes in the basins between the hills. The curving line of the hills, photographed with a low sun so that in the absence of vegetation every tiny surface irregularity is accentuated and the tracks of the camel on the crest loom like mountains in the foreground, is favoured as the typical desert scene. In fact only about one tenth of the Sahara is composed of *erg* or sandy desert and most other deserts have even less.

The wind may carry the finest of the dust beyond the desert borders where it is deposited on the windward side of any obstacle. This fine dust forms a soil known as *loess*, most important in north China on the lee of the vast, dry, interior lands of Asia. In temperate lands the wind can have little effect as the mat of vegetation prevents the soil being used as an eroding agent.

An earth modelling force that works more rapidly than all these has been *ice*. Following the last great epoch of mountain building most of the northern hemisphere passed through a period known as the 'Ice Age', or, to be more pedantic, the Pleistocene Glaciation. Great glaciers accumulated on the hills and after several centuries much of Europe and North America were blanketed by ice sheets several thousands of feet thick. The weather did not stay uniformly cold throughout the Ice Age: there were at least four periods of maximum cold and maximum ice cover, separated by long interglacial periods of warm sunny weather. Indeed some

scientists believe that the present time, less than 9,000 years since the great glaciers finally retreated from north Europe, may be yet another interglacial period. Remnants of the ice sheet remain in Greenland and there are a few tiny glaciers left in the high mountain valleys of the Alps, Norway, Alaska and other places, an unusual state of affairs in geological history.

Although, in terms of time on a world scale, the Ice Age occurred but yesterday and lasted only for a brief period of a few millenia, there is no doubt that as an excavator of rock and soil and as a transporter of the material excavated, ice has proved itself a most effective agent. As the glaciers advanced, whole regions were swept bare of soil. Masses of rock and rubble frozen into the base of the ice filed away the mountains and enlarged the valleys. The tremendous volume of soil, sand and rock waste was left behind as the ice melted or retreated, forming a deposit known as *kame* or terminal moraine. If the Ice Age had been a simple matter of one advance and retreat, we should find a wide area swept bare of soil and large dumps of this morainic material laid down on others. But because of the several phases of ice advance we find many complicated systems of terminal moraines and their associated features. So complex were the ice movements that recent research has tended to divide each of the four ice advances into two parts, and the last episode—the Würm advance—into three. Summer melt-waters flowing from the ice front flooded over the loose morainic material and spread out finer soil as an outwash plain. Rocks and finely ground dust from the base of the ice were dropped in many places as boulder clay, and the fossil beds of rivers that each summer flowed in tunnels within the

glaciers can be seen as long sinuous ridges of sand and gravel called eskers or øsar. In Europe these phenomena occur in an irregular sequence, moraines and outwash fans on the north German plain and the Baltic States, boulder clay in east Denmark and south Sweden and eskers in central Sweden and Finland.

Smaller glaciers in the mountains at the close of the period, filling perhaps just one valley, have overdeepened and straightened the original river valley, giving it a U-shaped cross-section as in fig. 5. The head of such a glacier frozen into the rocks of the hill gives rise on its disappearance to an armchair shaped hollow known as a *cirque* (*cwm* in Wales, *corrie* in Scotland) which is often in part occupied by a lake. Tributaries enter the main valley by water falls and themselves occupy 'hanging valleys', so that an ice-deepened valley consists of four distinct parts: (*a*) the cirque, (*b*) the deep, straight trench, (*c*) the shelf or 'alp' of the former river with its hanging valleys, and (*d*) the terminal moraine of the glacier responsible for the whole operation at the end of the valley. These glacial troughs are of some importance in mountain regions as ways of communication; the passes which connect one valley with another across such mountains as the Alps are also ice eroded. The change in slope in the tributary streams as they drop steeply into the main valley are being used for hydro-electric stations, and these are particularly important if the stream is fed by a lake on the 'alp', acting as a natural reservoir, to give a constant flow of water.

We need not go to the Alps, Norway nor North America to see examples of glacial activity. One of the most striking of terminal moraines runs across England from Shrewsbury to York, or in Ireland from the

Curragh, just south of Dublin, in a curving line as far as the mouth of the Shannon. Sheets of boulder clay, left by ice from Scandinavia, cover wide stretches of East Anglia, of Holderness, and occur as far north as Caithness. In Ireland the piling up of boulder clay, sand, and gravel on a peneplain surface of gently flowing rivers completely disrupted the drainage, and in later times there developed wide shallow lakes and peat bogs. All the stages of valley glacier erosion can be found within the British Isles: in the Highlands of Scotland almost every valley has been modified by ice, and the beauty of the Lake District depends upon the long, narrow lakes which lie in rock basins cut by ice.

We have spoken earlier of changes in the relative levels of land and sea. During the Pleistocene period when Europe and North America were covered by vast sheets of ice at least 10,000 feet thick, and when minor ice sheets were found even on the equatorial mountains, vast quantities of water were locked up and, as a result, the level of the sea became lower. The weight of ice pressing down on the continents depressed them a little so that on final melting and consequent raising of sea level there was a great flooding of the land. Since that time the land has gradually risen to its present height and in the Baltic is continuing to rise at the rate of half an inch per century. Traces of former sea levels can be found in fossil wave-cut beaches now high and dry. The highest of these is 100 feet above sea-level in Scotland, and others are found 50 feet and 25 feet above sea-level. They can be seen along most European coasts. The western parts of Norway, Scotland, Ireland, and elsewhere have a remarkable number of drowned glacial valleys known as fjords or lochs. There has been much

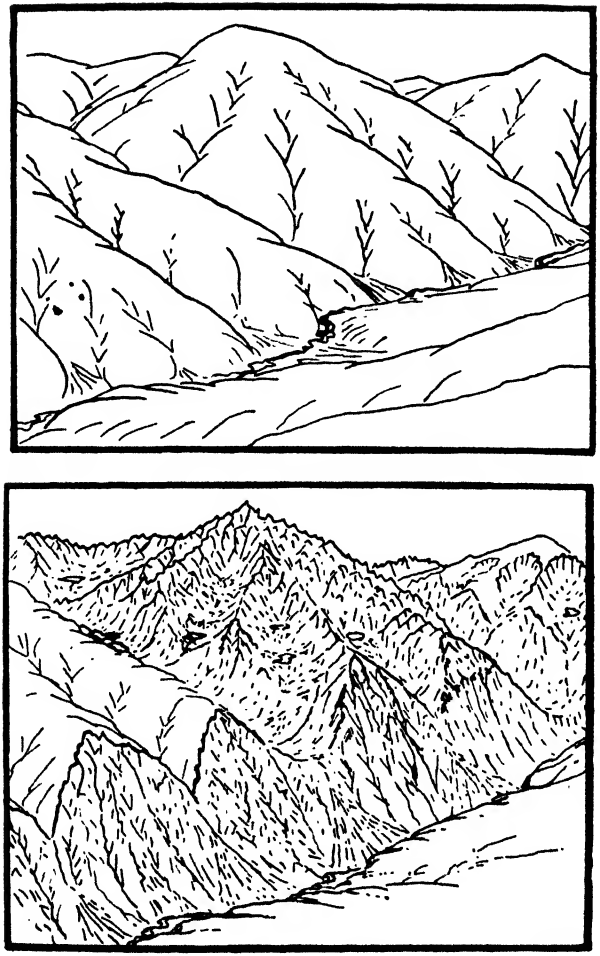

Fig. 5. EFFECT OF ICE ON A RIVER VALLEY.

after Davis S.G.M. 22 (1906)

controversy over the origin of fjords but it is now generally accepted that they are ice-cut valleys drowned by a change in sea level.

Before we leave this discussion of the effects of ice on the landscape, mention should be made of another controversy. Some physiographers hold that running water is the most effective agent of erosion and taking the world as a whole this is probably correct. The work of ice is, however, much more rapid and drastic than river action and if we remember the localized nature of the ice sheets and the relatively short span of their existence there is no doubt that in that time they accomplished much more erosion than any system of rivers could have done.

The Pleistocene ice sheets had other effects than mere moulding of the physical landscape. When Europe was covered by ice, no plants could grow; the wet winds that now cross the British Isles blew further south and transformed the Sahara into a waving grassland, with tree-lined river courses. After the melting of the ice, trees, plants, and animals which now included man, moved back into Europe from Asia and Africa but many species of plants could not recross the Mediterranean areas and the Alpine fold mountains. Consequently both the flora and fauna of north Europe lack much of the variety to be found for example in North America, where the mountains run generally north to south and where no water barrier such as the Mediterranean cuts off the temperate lands from the tropics. In the last two centuries numerous species of trees, native to North America and to east Asia, have been introduced and flourish in Europe, showing that there is no climatic barrier to their presence. The horse chestnut is a

common tree in these islands although a recent introduction from the U.S.A.; the western plane, common on city streets, also comes from the U.S.A. On the Continent many trees and bushes, now growing wild and very common are recent introductions: the most striking of these is the false acacia (*Robinia pseudacacia*), as common now in Europe as the hawthorn in Ireland but not more than three centuries on the continent.

This first glance at the surface features of the earth has allowed us to see the broad outlines. The great continental rafts, the ancient shields, and the mountain ranges, form the framework within which both the forces of weathering and the drama of human life are confined. The work of the agents of erosion forms a continuous cycle, from ruggedness to the smooth undulations of a peneplain. For its completion this cycle requires long eons of time and there are many signs that it has been interrupted by movements of the land or sea many times in the past. It is this unfinished nature of the peneplanation that gives such complexity and variety to the landscape. Each regional study in physical geography traces remnants of these *fossil* peneplains, as yet untouched by the work of modern rivers carving the surface down to present-day sea level.

Water is not only a vital geographic force on land, it is also important as an element in the atmosphere. Its effects under the cold weather conditions of the glacial period have already been mentioned and we must now turn our attention to its effect, as an element in climate, on the impermanent surface covering of the planet, the soils and vegetation.

CHAPTER III

CLIMATE, SOILS, AND VEGETATION

THE surface of the earth is rarely naked. Between the solid rock and the windy atmosphere the soil and the vegetation interpose themselves and in turn exert a strong influence on the life of man. If the solid rock was not broken into soil by the agents of weathering and if the climate prevented the growth of the necessary plants, then human life could not exist. Geographic facts such as this admit of no argument The study of geography in directing our attention to the influences that underlie in many subtle ways the growth and development of human civilization, influences that have determined the nature of the struggle necessary by human groups to ensure their survival in different localities, has all the fascination of dealing with fundamentals.

The soil and the vegetation covering of the skeleton of the earth are so much a product of the atmosphere that we must here turn our attention first to that most fluid of the envelopes surrounding the hard core of this planet. The reader will, however, be aware by now that geography studies its phenomena as parts of a whole and it will be no surprise to find remarks on the vegetation and the soils interspersed with descriptions of the different types of planetary climate.

The Ice Age has shown that the climate of Europe has changed much in the last 10,000 years. That is too long a time span for most purposes. Climate is so important that a special branch of science has grown up to study

it, climatology. In modern times aircraft depend on accurate predictions of the *weather* for knowledge of the winds at their aerodromes and along their routes. We are all familiar with the daily variations of atmospheric conditions in these islands; rain, sunshine, high winds, fog, and calm succeed one another often with startling rapidity. Such day-to-day variations make up the weather, and in view of the speed with which conditions may change the daily forecast gives predictions only for 24 hours ahead. Yet in addition to day-to-day events everyone knows that the seasons recur with certain regularity; that, in fact, the average conditions for any month in the year are very like the average conditions for the corresponding month in other years. These more general changes are referred to as *climate* and thus it would be fair to define climate as *average* weather.

Climate determines much of the life of this planet. Recent work in the U.S.S.R. and the U.S.A. has tended to show that climate, or weathering under different climatic conditions, tends to produce much the same type of soils no matter what the parent rock may be. And it should never be forgotten that about two-thirds of the people of the earth are farmers and thus directly dependent on the interaction of soil and climate for their livelihood. The British farmer has to deal with a climate that is cool and moist, the winds blow most frequently from the south-west and the year falls into four main seasons.

Such equability of temperature and of moisture conditions is rare and other regions of the world experience great extremes and a completely different seasonal pattern. Some generalizations can be made, however, for most people take it for granted that places closer to the

pole, that is higher in latitude, are colder and that the climate becomes warmer if we proceed towards the equator. In a previous chapter the distribution of the mountains and the physical features of the continents was shown to follow patterns and in the same way climate varies according to definite principles.

The first of these concerns the different heating powers of land and water. The oceans absorb heat slowly from the sun and give it out again slowly; land heats up quickly and cools down as quickly once the sun's rays are withdrawn. This is exactly the principle that determines the superiority of the hot water bottle as a bed warmer over the hot brick. Consequently, as land and water are unequally distributed, the climates of the continents show considerable differences: and since there is more land in the northern hemisphere than in the southern, northern climates are more varied. As the earth makes its yearly circuit round the sun and as its axis is tilted at an angle of $23\frac{1}{2}°$, the noon-day sun shines vertically overhead at different places at different times of the year. During our spring the sun is directly overhead at the equator on 21 March and by 22 June it is vertical at the Tropic of Cancer ($23\frac{1}{2}°$ N. lat.). From 22 June to 22 December the vertical noon-day sun is shining at points to the south of Cancer and by the latter date has reached its southernmost limit, the Tropic of Capricorn.

At the equator, then, the sun is always high in the sky at noon. As it beats down on land and sea both are heated and the air in contact with them becomes hot and rises up. Equatorial lands are lands of calms, known in the days of the old sailing ships as doldrums, for on the surface winds rarely move quickly. The hot

damp lower air ascends to colder regions in the upper atmosphere and drops its moisture as heavy thunder showers. One day is much like another, the sun rises within a few minutes of 6 a.m. and quickly dissipates the night mists, the day is a time of increasing sultry heat, eased slightly by a heavy thunderstorm in the early afternoon, and by 6 p.m. the sun has set. There are no seasons and the monthly variation of temperature throughout the year is not more than a few degrees. Under these conditions of heat and moisture vegetation grows apace and at the equator the most magnificent vegetative growth in the world is found. This is known as the *rain forest* where trees and undergrowth are so tight-packed that life is difficult for the larger animals and only small tree-dwelling creatures like birds, monkeys, and snakes are numerous. Despite the premise that man has probably developed from a hairless tropical primate, biologically attuned to this type of climatic régime, human life is difficult in these regions; man has tended to be crowded out by the vegetation. In the hot steamy atmosphere decay is rapid, diseases abound, and most primitive peoples find life a hard struggle. Even the modern European, with all the resources of a complex civilization to draw upon, has not yet mastered the art of living comfortably in this environment.

Only during the equinoctial season does this equatorial climatic zone extend evenly on either side of the equator, although 5° N. to 5° S. latitude is never outside its scope. Consequently, on either side of the equatorial rain forest there is a belt which has a dry season as well as a wet season, and as we go farther from the equator the length of the dry season becomes greater until

around the tropics in West Africa it occupies almost all the year. The rainy season does not commence on the first day the sun attains the vertical, there is a certain time-lag, best expressed by the saying that 'rain *follows* the sun'.

At Lagos, 6° N., the mean temperature of the coolest month is 75·7° F. and of the hottest 82·0° F., so that the mean annual range of temperature is only 6·3° F. The daily range may be a little greater, as much as 16°. In relation to the experience of other parts of the world, these temperatures are not high and the thermometer rarely exceeds 90° F. in any equatorial land; but they are very trying because of the dampness and the lack of seasonal change. Rain at Lagos shows already the effects of the movement of the belt of maximum rainfall with the sun. It receives 72·2 inches per annum, with rain during every month of the year, attaining a maximum in two rainy seasons once the sun has passed overhead. There is a major rainy season in May, June, and July with 57 per cent. of the annual precipitation, and a minor wet season in September and October with 20 per cent. of the rainfall. It must be remembered that although three-quarters of the rain falls in five months of the year every month is wet.

Where no rain falls or where rain falls so irregularly that plants cannot rely on it, bare ground with only occasional specialized plants is found. These lands, of less than 10 inches rainfall per annum, are the deserts. They lie in the belt of the Trade Winds, steady winds flowing from the desert regions of high barometric pressures, towards the equatorial band of low barometric pressure to compensate for the rising air currents in the doldrums. Owing to the daily rotation of the earth on its

own axis winds tend to be deflected to the right in the northern hemisphere and to the left in the southern hemisphere. A point on the equator makes a complete circuit of about 25,000 miles in 24 hours, a speed of just over 1,000 miles per hour, whereas near the poles a similar point makes a turn of only a few miles in length in the same period. Thus, winds blowing towards the equator in the northern hemisphere come not from the north but from the north-east. They are dry winds in North Africa because they originate over the land and lack moisture. Further west after the *North-east* Trades have crossed the Atlantic they bring rain to the West Indies and the north coast of South America. Consequently, in the latitude of the tropics we find deserts on the west coast of a continent and wet conditions on the east coast. This generalization applies to both hemispheres. In fig. 6 note the limitation of the hot deserts to the tropics and to the west coasts in Australia, South Africa, and South America.

In the Sahara the thermometer reached a world maximum of 136·4° F. at Azizia, 25 miles south of Tripoli, in 1922, yet the annual range is not excessive. At Biskra oasis, for example, 35·55° N. latitude in Algeria, the mean annual range is only 38·3°, from 51·1° F. in January to a maximum of 89·4° F. in July. The daily range however is very great: the sun beating down from the deep blue skies scorches the bare surface between the scattered desert thorns, and the air quivers with reflected heat. Midday shade temperatures are often over 100° F. When the sun goes down no blanket of clouds develops in the dry air, the land cools rapidly to temperatures in the region of 40° F. or below. It is not unusual for buckets of water out of doors at night to freeze during the cooler months of the year. No wonder

that desert peoples developed the sandal to protect the foot. The Sahara gets very little rain or cloud: steady dry north-east winds are the rule. Such rain as falls comes normally as summer thunderstorms but there is no regularity in its coming, and many parts may be without rain for years. At Biskra the total annual fall is 6·9 inches, with only April showing a rainfall of over one inch. In technical language we would say that in deserts the rainfall *efficiency* is at its lowest. To determine the efficiency of the amount of rainfall, its regularity and seasonal distribution is compared with the evaporation caused by the temperature in order to find out how much is available for plants.

Polewards of the steady Trade Winds there is another zone of low barometric pressure in the North Atlantic and the North Pacific. Winds here blow more stormily than in the equatorial low pressure and by deflection appear off the coasts of Europe from latitude 40° northwards as south-west winds blowing on-shore from the Atlantic. This warm damp airstream is the dominant feature of our climate. On the American continent within the same latitudes, the winds, blowing from the north-east, are cold and this influence is reinforced by the water from the Arctic Ocean flowing along the coast of Labrador and Newfoundland. Cold Arctic water is prevented from migrating southwards towards the Atlantic coast of Europe by a submarine mountain ridge from Iceland to Norway and the south-west winds urge warm Atlantic waters polewards. In consequence of this the western seaboard of Europe has milder winters than any other comparable area of the world. Murmansk, within the Arctic circle, does not freeze up in winter whereas the St. Lawrence river in latitude

50° N., the same latitude as Cornwall, is frozen for three to four months each year. The coast of British Columbia, on the west of North America, has a milder climate, similar to that of the British Isles, but high mountains prevent the maritime influence from penetrating inland.

To illustrate the climate of cooler lands to the north of 40° of latitude, we may give rainfall and temperature figures for a town of western Europe. Valencia in south-western Ireland may be taken as typical, with 56 inches of rain per annum, 58 per cent. of it falling in the winter half year. The constant on-shore winds from the Atlantic bring moisture at all seasons, with rather less in summer than winter. The total, as we know from our experience in Great Britain, is ample for most purposes. Temperature too shows a marked constancy: in summer the heat of the sun is tempered by cloudy skies and the moist airflow from the relatively cool ocean. Winter is kept mild by the same winds now blowing from an Atlantic that is relatively warmer than the land.

A mild winter means that there may be the possibility of growth out of doors all the year round, with the consequent enrichment of life in the environment. For this, the important temperature is not 32° F., the freezing point of water, but 42·6° F. the zero of plant growth, and to allow for daily variations the mean monthly temperature of the coldest month should not fall below 44° F. This condition is fulfilled on the coastal districts of south-west Ireland, in the tip of the Cornish peninsula, and in the Scilly Isles. At Valencia the annual range is only 14·6°, the mean annual temperature never drops below 44° F., and killing frosts are rare. Autumn is warm compared with spring, a characteristic feature of a maritime climate.

It is instructive to contrast with this the effect of land and sea on the east coast of continents. Asia affords the most extreme examples as it is the largest land-mass of middle latitudes. In summer it heats up and a vast low pressure is found on the Siberian plains; a smaller but more intense low pressure develops beneath the Himalayan and Sulaiman ranges in the Punjab. This latter low pressure system has far-reaching effects. It attracts the heated, moisture-laden winds from the Indian Ocean and is even strong enough to draw in the south-east Trades from beyond the equator. The winds arrive at the coasts of India at much the same date each year and drench the mountains with rain. They swing across the Bay of Bengal and travel along the Ganges valley: hills jutting across the main track, such as those of Assam, are soaked: Cherripunji tea station gets 428 inches of rain in the year, most of it (65 per cent.) in June, July, and August. This wet monsoon brings life to the rice fields of the lower Ganges, to the spice gardens of the west coasts of India; though irrigation is extensively used it is not always because of lack of rain, but to create the artificial swamp conditions on which the cultivation of paddy rice depends.

Monsoonal rain arrives in summer when it is of maximum use for plant growth and these lands support by their intensive agriculture the densest populations in the world: approximately half of the two thousand million people in the world live in the monsoon lands of south-east Asia, from the Indus to Japan.

'Monsoon' comes from an Arab word meaning a season, applied particularly to the season for sailing to India. As we have discussed above, the summer or wet monsoon blows from the south-west. The winter monsoon

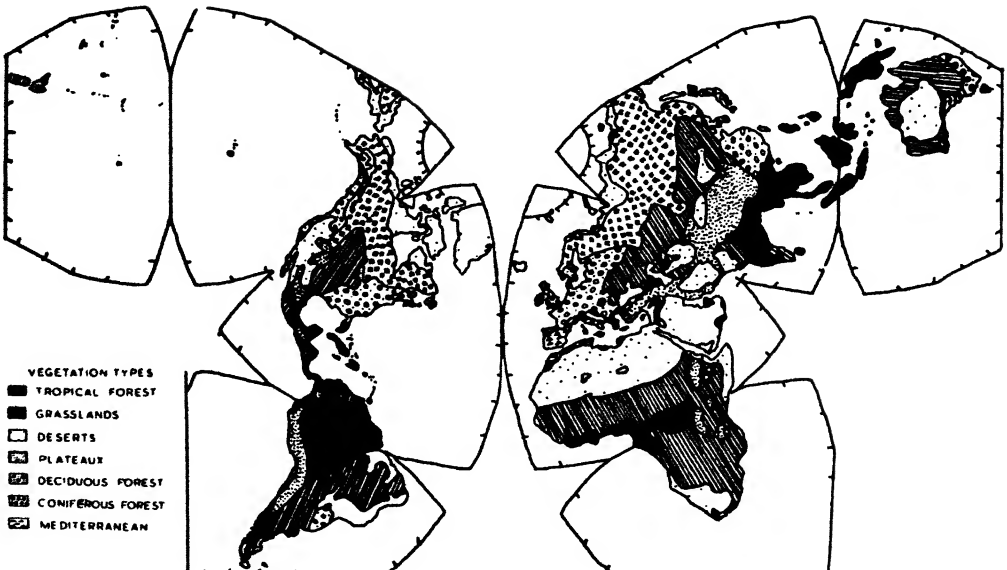

Fig. 6. NATURAL VEGETATION REGIONS OF THE WORLD.

on the other hand blows from the land to the sea. The continent of Asia, and the subcontinent of India, cool down rapidly as all land-masses do when the sun does not shine strongly: cold land chills the air and cold air spreads out from the heart of the continent. The coldest places on earth during winter are to be found in Siberia and from there bitter winds sweep out over China. The north Chinese say of the days when these winds blow, 'This is a three-coat day'. India is protected by Tibet and the mountain wall of the Himalayas from these cold airs, but again over India the winter winds blow from the north or north-east and, originating on land, they are dry winds, except for the particular case of Madras Province, where north-east winds before reaching the coast have crossed the Bay of Bengal and have accumulated a certain amount of moisture.

A monsoonal climate then originates from the distribution of land and sea and from the fact already stated that land and sea absorb and radiate heat at different rates. The year can be divided into two main seasons, a warm wet season and a dry winter, cool or cold depending on latitude and local conditions. These two divisions are separated by shorter seasons, a hot, dry period before the rains come, usually calm but often in coastal districts accompanied by violent storms called variously typhoons, cyclones, or hurricanes, and a cool, calm season before the onset of the winter monsoon.

The mean annual range of temperature varies from 3 degrees in Ceylon near the equator to 73 degrees in north China, but in all cases the rain comes in the hottest months of the year. It takes more rain to be effective as the temperature increases: more is lost by evaporation and also by transpiration from the rapidly

growing vegetation. In India or south China 40 inches of rain is needed to produce a luxuriant vegetation and 60 is desirable. This amount of rain falls on the coastal strip of western India from Bombay to Ceylon; hill stations here record around 110 inches during the monsoon. Eastward of the crest of the Ghats is a district of scanty rains, the famine region, where the descending winds have lost almost all their moisture and annual rainfall drops from an average of 75 inches to 20 inches or less. The second area of abundant rains in India (i.e. over 40 inches) extends from the Ganges delta to the Central Provinces and continues along the foothill strip of the Himalayas as far as Amritsar. Between the summer monsoonal rains of the Ganges and the irrigated *doabs* of the Punjab lies the Thar or Indian desert. Rain-bearing winds circulate around it but it remains waterless, an outlier of the great arid wastes of the Sahara and Arabia.

Asiatic monsoons are important because they influence the lives of half the world's population. On the opposite side of Asia, for Europe is but an extension of Asia, is a climatic régime important not because it influences many people but because the foundations of European civilization were laid in these lands. This is the Mediterranean climate found in lands around that sea and on the west coasts of other continents between 30°–37° latitude, in California, in Chile, in South Africa and in western and southern Australia. Lands with this type of climate are found as an intermediate zone between the hot deserts and the cool, moist, oceanic lands with gentle rain at all seasons. The peculiarity of the Mediterranean climate, and we shall confine our discussion to the homeland of this variety, is that the bulk of the rainfall occurs during

the cool season so that plants have either to complete their life-cycle during this period or develop special methods of withstanding the heat and dryness of summer. A simple explanation is that these lands are affected by the movement of wind belts as the overhead sun passes from the northern tropic to the southern tropic. During the winter season of the northern hemisphere the Atlantic westerly winds blow to the south of their summer track, they too 'follow the sun', and so bring rain to the Mediterranean coastal littoral. That, however, is perhaps an over simplification. These Atlantic winds as we all experience them are not a simple air flow. They arrive in Great Britain as part of a series of weak low pressure systems, formerly known as cyclones but now called depressions. Each depression brings its own sequence of weather: a 'front' of warm continuous rain and cloudy skies, followed by a period of much cooler and stronger winds, heavy showers and patches of blue sky between the scurrying black and white clouds. Depressions are composed partly of warm, moist Atlantic air and partly of cold air from the Arctic regions. The weather they bring is not invariably as described above: there are many alternatives to that pattern.

In winter, as the continent of Europe cools down, the Mediterranean remains relatively warm and local depressions arise over the basins of that sea. Damp Atlantic air is drawn in and brings winter rainfall to these lands. As the winds blow in a clockwise direction the western slopes of the peninsulas receive more rain than the eastern. This rain rarely penetrates far inland and the typical winter rains of the Mediterranean countries, the former and the latter rains of the Old Testament, occur most reliably on the seaward slopes of the hills.

In contrast to the cool winter, the summer is a period of heat and drought, the area being then under the influence of the dry north-easterly winds. These are the Etesian winds that carried the Greeks to Egypt and blew Egyptian barges up the Nile against the current. A theoretically ideal description of the climatic régime of the Mediterranean would make no mention of summer rain, emphasizing rather the dry sand blast from the Sahara, such as the Sicilian sirocco. In the world of reality there are always some exceptions to the rules, and along the northern margins of the Mediterranean occasional summer rains are brought by stray depressions from the stream along the northern slopes of the Alps.

A typical Mediterranean station is Athens where the temperature rises from 46·4° F. in January to 80·6° F. in July, a mean annual range of 34·2°. Annual rainfall is 15·4 inches, almost all arriving in the winter six months, October to March. The controlling factor in plant growth is therefore water rather than temperature, in contrast to Europe north of the Alps.

Vegetation must be highly specialized in these countries to withstand the long summer drought. The natural growth is not a great tall forest as at the equator or in the regions of monsoonal rains but a thickly matted, low, scrub forest, known as the *maquis*.

As we go northwards in Europe, winters become colder; the dominant feature of the climatic year becomes neither the mild Atlantic breezes nor the hot Saharan winds but the cold air from Siberia. At Leningrad only the five months from May to September have average temperatures of above 42° F. This cold winter is typical of the interiors of all large continents and is directly due to distance from the moderating influence

of the sea. The cold winter high pressure is replaced in summer by a low pressure as the land warms up. In Europe at Leningrad most (58 per cent.) of the annual 19 inches of rain falls in the summer months and is derived from Atlantic depressions voyaging towards the low pressure of the continental interior.

Thus far we have distinguished several different climatic zones, dependent on distance from the equator, distance from the ocean, and position on the east, interior, or west of a continental land-mass. The business of a geographer is not primarily to study the mechanism of climate—that, as we said, is the field of work of the climatologist; geographers are concerned to work out the limits of climatic regions and, of course, to do this some knowledge of the climate and of the determinants of climate is necessary. The drawing of limits in this world is a task of great delicacy for nowhere are there sharp divisions; even high mountain zones may lack precise boundaries because of foothill ranges, skirting plateau blocks, and so on. One type of climate shades into another and therefore it is not surprising that many different maps of the world have been constructed to show climatic provinces. Most agree in their major divisions, though the exact delimitation of the boundaries may vary.

For the geographer climate is but one important factor in the life of man on the earth. Another most important section of the environment is the soil. The landscape, the climate, and the vegetation all help in the production of the soil cover. At first the solid rock breaks down into large pieces through chemical weathering and through the action of frost and other physical factors. These broken rock masses are eventually

reduced in size and some plants begin to grow. From that point onwards the soil is enriched by the decay of roots and leaves, by bacterial rotting, and by the working of earthworms and insects. The soil is a complicated blend of living and dead matter.

Given a long period of stable conditions and a landscape composed of plains or gently rolling country, the evolution of the soil is more dependent on climate than on the characteristics of the underlying rock. A mature soil, such as this, can never develop on a hill slope because fresh layers of rock detritus and plant remains are, under the influence of gravity, slowly slipping downhill, nor can it develop on a river flood plain for there fresh deposits are constantly being added.

Pedology, or soil science, is a relatively new branch of knowledge. Its development occurred, significantly enough, not in western Europe where much of the soil is based upon a haphazard mechanical mixture left by the recent Ice Age, but in the great continental expanses of Russia and the U.S.A. In these countries there occur vast areas where the blanket of soil pass almost without change over several types of rock, and this has focused attention on the effect of vegetation and climate on the rock particles. These mature soils require either plains or country with gentle undulations for their emergence, and in their evolution three processes are important. Some of the rain falling on the surface sinks into the ground and, unless the underlying rock is porous, builds up a water-saturated layer at varying depths. In its passage from the topsoil to the underground water table, this water performs the first two of these soil forming processes: (*a*) the washing down of fine particles of clay to the deeper layers, thus giving the topsoil a coarser

texture, and (*b*) the removal of soluble chemicals such as lime, potash, and phosphate from the surface. The third action is the accumulation of the decayed vegetable matter called humus.

The considerable variety of climate, of types of vegetation, and in the slope of the land, together with the effects of the Ice Age, river flooding and wind-blown dust, all combine to produce a considerable complication in the soil map of the world. The topic is, however, of considerable interest and importance because all animal life depends on the vegetation produced by the interaction of soil and climate, and agriculture depends on the co-operation of man working within limits set by these forces. Vegetation is not merely a result of this mixture but is an active agent in the establishment of the characteristics of the soil. It is the vital contribution of geography to the sciences to be able to embrace such complex syntheses as these and, by plotting their spatial relationships and considering their distribution in relation to other factors, to make its own interpretation.

In such a book as this we can do no more than hint at processes and give selected examples. Here we may consider mode of formation of the soils of the grasslands as typical. Grass is the natural vegetation cover wherever the rainfall is insufficient for the growth of trees: it thus tends to occupy the two zones of transition between the equatorial forests and the hot deserts and between the deserts and the broad-leaved forests of temperate latitudes. From the point of view of soil formation the special characteristic of grasslands is that they produce far more vegetable matter per year than a forest: the annual decay of roots and stems in the absence of a heavy rainfall enriches the humus content and consequently grassland

soils are dark in colour. One of these soils, the chernozem or black earth, has been called the richest soil in the world. It is often up to three feet in depth with all levels impregnated with the fertile humus. While the topsoil is often composed of relatively coarse particles, the rainfall is just sufficient to carry fine material and mineral salts, principally lime, to the lowest layers where they accumulate and add to the fertility. In regions of heavy rainfall, as in the tropical forests, both the decayed vegetable material and the mineral salts are washed into the deeper layers and eventually out of the soil into the rivers. Thus tropical soils, with the exception of river flood plains, are often yellow or red in colour and infertile.

Black earths are only formed under the most favourable conditions. To-day they supply the granaries of the world, in the Ukraine, in North America, in Argentina, and in Australia. Grain growing is also important on the margins of this special soil type. In the U.S.A. there are great areas of black prairie soils differing only from the chernozem in being slightly shallower (20–24 inches), and in having a slightly higher concentration of lime and other soluble materials in the subsoil. Asiatic Russia has a wide expanse of short grass steppe where the soil colour reflects the short herbage by being chestnut-brown rather than black in colour.

Until quite recently it has been customary to write about natural vegetation before human interference as if there was some intrinsic virtue in the simple environmental response. Now we consider man as an integral part of nature and his influence on the plants and animals of a landscape is as cardinal as that of the virgin vegetation. A recent study by an American scholar has put forward the thesis that all the grasslands of the world

may have been created by man. This is supported by an intensive study of the prairies of North America since the close of the glacial period. The effect of the use of fire by primitive hunters during a period when the climate was becoming drier was to oust the trees and encourage the grasses. If this theory receives general acceptance then there can be few areas of the world in which the influence of man on the vegetation has not been considerable.

The major natural vegetation regions are shown in fig. 6. In this diagram the relative sizes of the land areas are correct and their shapes are little distorted but this is only achieved by many breaks in the graticule.

Human groups have existed in all environments from the equator to the poles. Man has lived happily on the sandy wastes under the hot, dry sun of the tropical deserts and in the long, cold Arctic night. Farmers have ploughed fields in grey soils, leached of their fertility by constant rains, in red soils under an equatorial sky, on the deep black chernozem, and in the oases. The topography of a country, whether rugged or unbroken plain, the type of climate, the potentialities of the soil and vegetation, all these physical factors are of great importance and together they constitute the field of study of the physical geographer.

As we have seen, we may study as an end in themselves the distribution of the mountains, of climates, of soil types, or of natural vegetation. To a human geographer they set the stage for man and it is in the light of human activity that we in this book must try to understand all these factors.

CHAPTER IV

ENVIRONMENT AND MAN

THUS far we have been considering the physical factors that influence the earth, mighty forces folding, twisting the surface, splitting and tearing it apart; drenching the continents with life-giving rain or parching them with scorching heat, wearing away the mountain peaks, cutting down the valleys. In face of these the individual man appears puny and insignificant. Man is such a *parvenu* that his influence on the earth could easily be negligible. It will be often easier to trace his destructive operations than his achievements. So if he has drained the Zuider Zee or built the Boulder Dam he has also in his passing left great tracts of once fertile grasslands to be scoured to deserts and wiped out desirable species of valuable land and sea beasts. But to see these efforts in proportion we must line in man's attempts to adapt this earth to his purposes. This chapter will be devoted to the attempts made by peoples who had not the entire planet at their disposal and had perforce to live on the products of certain lands, their homelands.

There have been men like us in the world since the closing stages of the Ice Age and, as they appear in the record fully developed and of several distinct types, probably they existed from near the beginning of the Ice Age. All in all, however, the time-span in years is not much over 500,000, a mere yesterday in comparison with the age of the planet. Nature works very, very

slowly and in the opening scenes of human history man's role in altering his environment must have been so slight that it might appear unimportant.

In far-away corners of the globe we find human groups not much advanced in the arts of society. They occupy portions of the earth which other men with more skill in obtaining food did not desire or had not reached before the Europeans discovered them. Let us look at some of the places where they are found and at the type of life they lead, remembering that basically they live much as our own ancestors did down to about 4,000 years ago.

All these primitive people are exploiters of difficult environments. They have no knowledge of growing crops or of herding animals: that is to say they pick their subsistence from day to day, very occasionally gorged so full of food they can hardly move, but usually hungry. Each community lives in small family groups, meeting for the most part once a day in the evening for a meal. The men then bring in the spoils of their hunting to be shared among all the families of the party. This sharing ensures that no meat shall be wasted, that everyone is certain of a meal and that success in hunting, which one day may go to one man and another day to another, is equally desirable to any man. The women and children contribute the roots, berries, and insects they have collected during the day. All these hunting and gathering peoples eat everything that is edible—roots, berries, flowers and fruit, insects, grubs, birds, fish, and game: in times of scarcity they will even eat the soil itself. Planting nothing, taking everything from nature's storehouse, struggling with inadequate tools against a hostile landscape, they yet lead happy lives and in most cases

die out rather than adapt themselves to meet new circumstances.

The continent of Australia was such an isolated habitat, protected by island barriers and dangerous seas from the millions in south-east Asia. The blackfellow, a cheerful, happy-go-lucky type, with no thought for the morrow, has declined in numbers following contact with white civilization. New diseases have taken a heavy toll; measles wiped out complete tribes, who had not previously had any need for immunity nor any opportunity to acquire it. They make good herdsmen on a sheep station, confident and alert to every movement in the countryside. When they return to their own tribal group they put off new ways of living like a garment and return to the old. Any presents of livestock are no longer regarded as domestic possessions but fair game and soon killed for a great corroboree.

Similar groups, tucked away from early movements of tribes, are to be found in South Africa. The Bushmen of the Kalahari were pushed off the game-abounding veldt in the last thousand years by the better armed and more advanced cattle-tending Bantu peoples. Hunting groups exist also in the great rain forests of the tropics. The fringes of these virgin forests have been settled by farmers but the innermost recesses are fastnesses where the vegetation was proof against the axe. Here in the Congo basin we find the elusive pygmies, skilled hunters, expert trappers, and collectors of wild products. To-day they require iron for knives and arrowheads: the diet of the surrounding negro farmers is lacking in variety and they love meat, so the pygmies exist as meat suppliers in return for iron goods and to a lesser extent grain and cultivated vegetables, such as the yam. In the Far East,

too, there are groups at the same stage of development, sometimes tall and hirsute like the Australian blackfellow, sometimes dwarf and kinky-haired like the pygmy. They exist in Ceylon, in Malaya, in Borneo, in the Phillipine islands, and new groups are occasionally discovered as the islands are more fully explored. In Arabia, too, there is a community of skilled gazelle-hunters, the Solubbi, who have the double function of supplying meat to supplement the grains and dates of the oases farmers and of acting as travelling tinkers.

For peoples who are food gatherers and hunters the world is, as the Bible says, 'all overgrown with thorns and briars' in the sense that every wild plant is either a thorn or a briar, that is, unwanted by cultivators. Even in the most favoured localities nature gives an uncertain maintenance; population is limited not by the periods of seasonal plenty but by the longer seasons of scarcity. The numbers of individuals must remain small. It has been said of California where, before the sixteenth century, there lived about 150,000 collectors, 'there were very few Californians and in proportion to the size of the country almost as few as if there had been none at all'. In the whole of Australia there were probably never more than 300,000 blackfellows. For support by the collection of nature's 'bounty' every individual requires almost a square mile of country. The isolation and loneliness that this imposes are difficult to imagine. The great ceremonies at the yearly season of plenty may gather together for a fortnight or three weeks some 500 persons, and at most in the favoured south-west of Australia 3,000. If we compare these ephemeral *annual* contacts with the *weekly* range of meetings of a European farmer at church or market, we may gather some

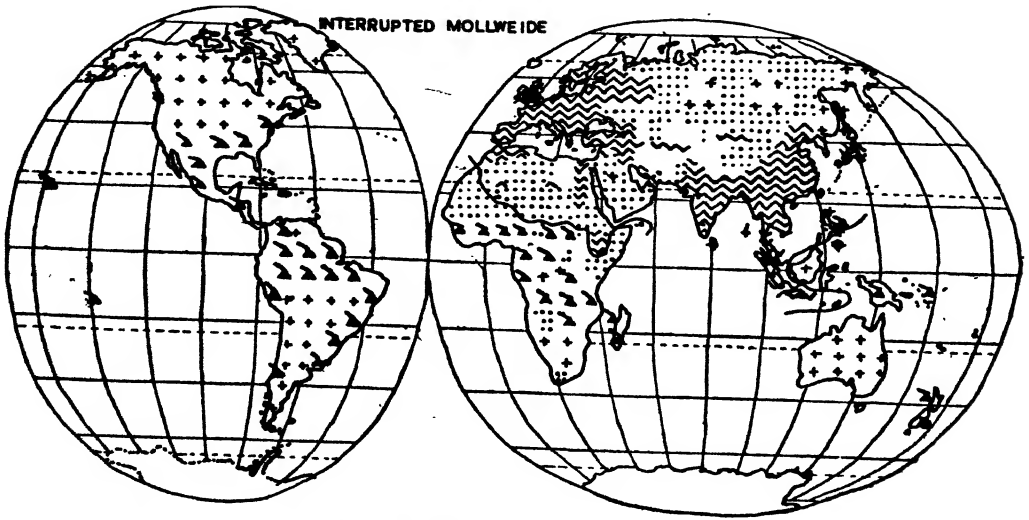

Fig. 7. SOCIAL GROUPS OF THE WORLD BEFORE 1500 A.D.

idea of the isolation of the food gatherer. Further, these collectors will be divided into small groups speaking mutually unintelligible languages, following different customs according to their ages and sexes. Even in a small area like the Andaman Islands, out of a population of 500 in 2,000 square miles, there were nine hostile tribes and three language-classes, each group within a tribe speaking dialects not all of which could be understood by their neighbours. A similar state of affairs would be found in the British Isles if the population of each village formed a tribal group with its own language, flag, and other sentiments of loyalty; if each street within the village spoke a separate dialect and was kept conscious of its separate identity by a body of customs and traditions, including the refusal to marry foreigners from across the village green.

As more and more of the earth is brought within the influence of white civilization, these groups tend to disappear. The Tasmanians have already gone as a pure-blooded race and others are almost sure to follow. Their fate throughout the ages has been to be pushed away from lands wanted by other people, into the hot steamy unhealthy equatorial forests, into the deserts at the southern tip of Africa, into the frozen wastes of the Arctic, where the Eskimo, happy seal-hunters, live in contentment despite great hardship. Others have found a corner of the world far off the main routes of prehistoric travel such as Australia, eastern Brazil, or California.

Another primitive form of social organization has survived on the grasslands of the Old World. These are the herding peoples who, since the domestication of animals in antiquity, have been the dominant exploiters of this environment. Only a few wild species were found to

multiply in captivity; of these, cattle, sheep, the horse, and the camel are most important. The domesticated varieties, protected and improved by the herders, are now incapable of a separate existence. Together with the human population, who likewise could not live in these areas without the animals, they exist in a complex adjustment to the landscape. Let us look for a moment at one of these areas. In central Asia even to-day, with the extension of the grain-growing areas of the U.S.S.R. on to the Siberian black earth soils and with the construction of irrigation works in Turkestan, there remains a vast acreage suited only to nomadic herding. This is the Kazak steppe between the Caspian and Lake Balkash, an austere environment left until recently to the aboriginal inhabitants. Physically it is gently rolling or level country about 1,000 feet above sea level with some hills on the southern border which may rise to 4,000 feet. Around these granitic hills spread great fans of rock waste and out on the plain there is much bare ground between the scattered clumps of vegetation, both signs of arid climatic conditions. On the northern border there is a wide corridor where the grasses form a continuous turf, where no tree breaks the monotony of the skyline, but where the rainfall is insufficient for the growth of cereals. The Kazak steppe lies in the heart of Asia, midway between the Arabian Sea and the Arctic Ocean; the climate, in consequence, is one of extremes. Winters are long and cold; 70 or 80 degrees of frost is not uncommon. Snow falls abundantly but high winds on the treeless plain blow most of it away so that it piles up in deep drifts in the depressions and river valleys. Spring comes suddenly in April and in two or three weeks the snow is gone; the ground, frozen in

winter to a depth of 6 feet, thaws out gradually, new grass appears and the depressions hold the melt-water as temporary lakes. By late June the sun has risen high overhead and heat and desiccation set in. Temperatures run up to 104° F. during the summer days and occasional heavy thunderstorms bring only temporary relief. Such rain as falls arrives in early summer from the north-west as thunderstorms, but it is most irregular and absolute droughts of two years or longer are not uncommon.

For the herding peoples the great problem is water for the beasts at the height of summer. During spring and the early part of summer the steppe is dotted with ponds filled by the melted snow. Occasional ponds may last through the summer but they become more and more salty. Access to the five permanent rivers is eagerly sought, although all these streams are subject to sudden severe flooding in spring and all drop to a mere trickle by the end of summer.

The use of such an environment by pastoral nomads involves them in constant movement for much of the year. Grass is insufficient for large herds; the richer areas that might have supported larger numbers of animals have now disappeared under the plough. Only during the winter can they live a stationary life for a few months, a cramped existence in rectangular huts (*kstau*) built of withies and reeds and covered with earth or sods. These structures, surrounded by corrals for the animals, occupy a permanent site in some sheltered river valley, usually in one of the hill-masses on the southern edge of the steppe. With the coming of spring in mid-April each family slips away quietly with its flocks to take advantage of patches of herbage on the

barrens located by its horse riders. Once the grassy plains are reached the early summer pastures and abundant water allow the animals and the men to put on weight after the rigours of winter feeding. In the heat of summer the drying up of the water supplies makes rapid movement necessary over the parched pastures. Summer rains and cooler conditions in late September and October permit a slowing up of the rate of movement, and at this season of comparative plenty the ceremonies and the tribal gatherings take place. Soon, however, comes the rapid dash back to winter quarters. A single family may move 500 miles in the course of a year.

The Kazak, called Kirghiz by the Russians to distinguish them from the Cossacks, were able to follow this itinerary only because they had evolved suitable equipment. The cylindrical domed *yurt* or *ooi* was the summer dwelling-place, built on an expanding lattice framework and covered with felted material. Their whole wealth lay in the herds of fat-tailed sheep, cattle, and horses. Camel breeding was also important. In Turkestan was the one-humped camel or Arabian dromedary; further east the two-humped, bactrian, camel replaced this as it had a rougher coat and so was better adapted to withstand the colder winters of central Asia. Moving from feeding ground to feeding ground, herding their animals constantly as a protection against wolves and other nomads, limiting their material equipment to the essentials that could be easily carried, these people had little time for gathering wild products even if they were available. As Aristotle said, 'the herder farms a living farm'. The staple diet is milk in one form or another; sweet and sour boiled milk cheeses are made from cow's or sheep's milk. The

rich alone can enjoy *kumiss*, fermented mare's milk. *Airan* (milk and water) is the common drink and the diet is supplemented by unleavened bread fried in mutton fat. Millet grain for bread and porridge is obtained by trade from the sedentary peoples of the oases on the southern border of the area. The nomads bring in hides and craft products such as finely-worked leatherware or ornamented felt, fruits of their long leisure whilst the animals graze peacefully. Although they lead lonely

Fig. 8. DRY LANDS AND CARAVAN CITIES.

after Vidal de la Blache

lives there are many more people than in a similar territorial area occupied by food gatherers, and everywhere through Asia and Africa the pastoral nomads of the steppes and semi-deserts are in trading contact with sedentary cultivators and depend on them for certain luxuries, for tea, coffee, grains, and manufactured goods. Fig. 8 shows the distribution of the major caravan cities which these nomads visit. The only nomadic groups wholly isolated from contact with agriculturists are the reindeer-herders of the far north of Asia. Some of the Kazak even attempt a little rudimentary tillage

around their permanent winter quarters and all make some provision for the winter by cutting and storing meadow hay for feed. In recent years with the collectivization of agriculture on the black-earth soils under the successive five-year plans the Kazak steppe and its neighbouring areas have been brought more and more into contact with other forms of life. While there is still a great area over which herds and herders wander, the tendency has been to use these drier lands for ranching. Breeds of cattle, sheep, and horses have been improved by the introduction of new strains. The herder still retains his pride in his animals, in their quality as well as their quantity, but more and more he is becoming settled and his stock is destined for consumption in the rising cities of the Turkestan cotton belt or the areas of heavy industry growing up in the Ural-Kusnets-Karaganda triangle to the north. This commercialism is a revolution in thought and practice for these peoples accustomed to live on animal products and to conserve the individuals in the herds, as signs of wealth and prestige.

In the past the nomad herding band, accustomed to co-ordinated manœuvres in the rounding up of large unruly herds of animals, inured to hardship, to facing sudden emergencies of wild beasts and wilder men, was a ready-forged fighting unit. As we have seen, the great interior continental plains are subject to extreme variations in climate from season to season and even from year to year; they are far from the moderating influence of the sea and they are grass-covered because the rainfall is too scanty for the growth of trees. In such an environment large herds, living under primitive conditions, are subject to sudden fluctuations both through

disease and starvation due to lack of pasture. Nomads therefore often face sudden emergencies in their homeland and they may react by thrusting out from the dry interiors and trespassing on the more fertile fringing lands of the steppes, occupied by farmers. In the course of history they have swept out again and again as marauders and become herders of men instead of beasts, overthrowing by their superior discipline and mobility vaster numbers of the footmen of the plains. One great wave of migrations from south Russia swept away the Roman Empire; movements to the east have given many nomad dynasties to China. The nomads have given many characteristics to our western society, influencing even minor matters like the dress of the dominant males, for trousers were first designed for horse riding and the bowler hat as a crash helmet.

In Russia and Siberia nomads have not gone northward into the dark, close-packed coniferous forests. There were no men there to conquer in early days nor was there any hope of pasturage. The mountains to the south of the steppe have been a less formidable barrier. From a physical map the way from Turkestan to the Arctic appears open and smooth in comparison with the wide, lofty, and extensive mountain arcs between the Caucasus and the Himalayas. But every mountain range has passes and through these the northern nomads filtered. They overran the early kingdoms in Mesopotamia, Egypt, and India: as the Seljuk and Ottoman Turks they conquered again in the Middle Ages. The Great Wall of China, one of the most stupendous of human undertakings and a major example of human activity in altering the landscape, was built to shut out the Asiatic nomads. The history of India, until the

coming of the Europeans by sea, was a long succession of conquests by peoples who entered by the Khyber and other passes on the north-west frontier.

The study of geography shows readily the underlying similarities of these movements. Its presentation of the life of such peoples, delicately attuned to a dry grassland environment, upset by alterations in the weather, or bacterial changes causing epidemics, helps us to understand the sudden outrush of an organized horde on the unwary cultivators, who in contrast to the steppe dwellers would be soft with good living. Human movements are canalized by geographical barriers. The steppe with its open vistas allows free movement outwards in any direction to its own margins. Forests of conifers to the north are an absolute barrier, the open broad-leaved forests of Europe slow down but do not stop movement, mountains are less of a barrier than the pine forests as there are always passes through them. These geographic factors mean that, in general, human migrations on the Asiatic steppes, following the 'natural' routes of the terrain, are made in an east-west belt from Hungary to north China.

Pastoral nomads contributed much besides trousers to the life of the world: the milk of animals relieved women of one of their heaviest burdens. Milk produced healthy children with no limit to their numbers, quality with quantity in population. Hunting groups cannot increase beyond the natural food supply and all of them practise some form of infanticide. Neither meat nor the grains of agriculture can be easily digested by young children. With the nomad, as the herd increased so could the population. Even the prodigal son was welcomed back; all hands were needed to tend the growing herd.

Pastoral nomadism developed in the heart of Asia in short-grass country essentially similar to that of the prairies of the U.S.A. and Canada. In America, however, we find no trace of pastoral nomadic societies. The Indians of the Great Plains remained hunters, parasites of the bison, and even when they eventually acquired the horse from the Spaniards, and could move rapidly, they used it merely to extend their hunting range. A glance at the geography of the region may help to explain this lack of developed society. In Asia, the reader will remember, the grassland strikes east and west between the coniferous forests to the north and the mountains to the south; the edges of the grass steppe are divided into many isolated pockets; extensions run into the great southern valleys penetrating the Tien Shan and the Altai Mountains; on the northern edge forest glades isolated by more or less pure stands of timber break the transition from grass to pine woods. Here men and animals could come close together in a common search for water and food and remain in isolation long enough to develop intimacy and permit eventual human control. Domestic animals led by these human groups could then expand and multiply on the great plains. The geography of the terrain encourages such a development even if it does not enforce it. In contrast the grasslands of North America have their maximum extent from north to south, ranging thousands of miles from the Peace River of Canada to Texas. In America, too, the bison was the only animal that might have been domesticated, but the herds, far from staying peacefully in a small area, on their annual migrations moved rapidly from south to north and back again. They followed the melting snow and almost kept to a timetable. Thus,

human groups could meet and follow the herds and kill enough animals for their needs, but they could never establish that intimate contact which is a necessary preliminary to domestication.

In large numbers cattle will consume grass faster than it will grow and so nomads must constantly be on the move, looking for fresh pastures or in search of water. Each group has its own area within which it moves and from which it strays only when driven out by force of circumstances. Not all domestic animals are capable of this constant movement; cattle, sheep, horses, and donkeys are favoured. Sheep and goats are the 'cattle' preferred on the hill slopes. In contrast the pig, a native of the hot, wet forests, is never found far from the farmyard in domestication and is unsuited to the nomadic encampment.

Humanity learned the rudiments of agriculture about 6000 B.C. The discovery seems to have been the achievement of peoples living on mountain foothills. Authorities are still in some disagreement over the exact locality: some sponsor the Abyssinian plateau, others support Persia, and a third group favours the hilly zone extending from Palestine to Anatolia. Tradition has placed the 'Garden of Eden' there, but arguments for the other two alternatives are very strong. Viewed from the standpoint of the world as a whole there is little need for us to be too strict on the detail of the locality. The triangle Abyssinia, Anatolia, Persia, or to put it another way, Caspian, Persian Gulf, Red Sea, is the very cross-roads of the continents where men with different environmental backgrounds and experience have met in greater numbers than anywhere else in antiquity and where new ideas called forth a fruitful response from nature. Nor

need we suppose that the peoples living here had a superior mental equipment. The geographical conditions, human and physical, were just right, and it is no accident that agriculture and civilization based on agriculture began there.

We think of farmers as stationary, rooted to the soil, but some farmers are mobile, though they move less than pastoral nomads and much less than hunting peoples. Nearly all farmers in tropical and equatorial lands practise a form of shifting cultivation. They cut down the undergrowth, remove creepers and the smaller trees, pile them together and burn them after the brief dry period. Some peoples in the Amazon are so skilled with their polished stone axes that they not only remove the creepers but notch all the trees in the area to be cleared and then cut down a forest giant on the edge which in its fall tumbles everything with a resounding crash. Under a tropical sun the ashes from the fire give enough fertilizer to produce magnificent crops for a few years. In some places, for example in Borneo, new forest is cleared every year; other tribes use the same land for as long as five years. After an interval of a few years, however, all the available land within reach of the village is exhausted and the huts must be deserted. A new village is built and a new area of forest attacked. The implements of slash-and-burn agriculture are the axe and the digging-stick or the hoe. Vast areas of primeval forest have been altered by these peoples; for, once cleared, the earth is scorched by the hot tropical sun pouring through the gap in the leafy canopy. The heavy daily rains wash the valuable mineral salts out of the top soil and the giant trees do not readily grow again. The rain forest is replaced by a

jungle of smaller subsidiary trees, bushes, and creepers.

Shifting cultivation is generally condemned as destructive of the forest and as a lazy and inefficient method of growing crops. It is certainly not a lazy man's way, for the felling of great trees even with a steel axe calls for strenuous effort. Once the clearing is made it must be protected against wild animals, for each 'field' is normally isolated in the forest. It is a wasteful way of using the land but we Europeans have not been able to devise a better for these regions. Our experience of cultivation

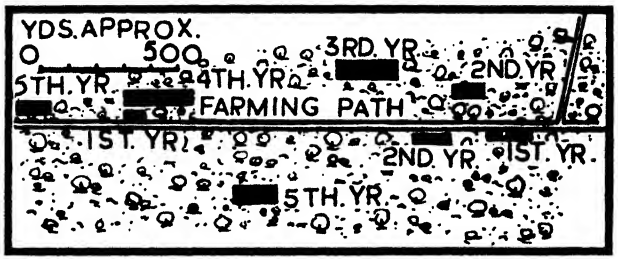

Fig. 9. FOOD PLOTS IN WEST AFRICA.

after Forde

in the cleared broad-leaved forest zone of Europe—with its deep ploughing, animal fertilizer, and the rotation of crops—is useless under tropical conditions. The crops we have grown successfully in the equatorial belt are tree crops, cocoa, palms for oil, and rubber.

Slash-and-burn farmers are found in all areas of the rain forest. Using the iron hoe and the labour of the womenfolk, farmers at this level operate in all parts of Africa south of the Sahara, but especially in the Guinea coastal strip and the Belgian Congo. Amazonia, where even modern white civilization has had difficulty in gaining an ascendancy over the vegetation, is occupied

by many scattered groups of crop producers. Despite the vast river network, more virgin forest remains than in Africa. The Amazonian natives are not so well adapted biologically to their environment as the African negro. The riches of Amazonia have hardly been touched, yet already it has yielded the rubber tree, vital to road transport and to the making of waterproof clothing, the cassava root, cacao, and vegetable drugs such as cocaine and quinine. All these now enrich life in other areas of similar climate, and quinine made life possible for Europeans in the tropics. In addition to the human factor, the very size of Amazonia inhibited exploitation; it is more low lying, extends further from the sea, and contains larger tracts without water transport than the Congo basin. It is significant that the area of the rain forest most completely penetrated by peoples with the tools of higher civilization is the East Indies where the sea allows easy communications. Here both the buffalo-drawn plough of the rice lands and the equatorial tree crops of modern commerce are found. It is the only area of the world where the plough had been taken south of the equator before the age of discovery.

Slash-and-burn agriculturists are to be found on the flanks of the rice fields from India to the Philippines. It is one method of growing crops on the hill slopes; many tribes of Central India, Assam, and Burma practise it under one name or another. Our ancestors in Europe may have practised something similar for a Greek legend says:

> Now I am already so old, that the meadow by yonder house,
> Has been nine times meadow and nine times wood.

Field-work with the hoe or the digging-stick is almost always left to the women; the men hunt, gather wild

products, or attend to cattle. The use of women in the fields is one reason for the occurrence of polygamy in Africa. Many wives mean an increased labour force and the fact that women during pregnancy and lactation are unfit for labour in the 'gardens' also encourages the practice. These tropical lands in Africa, America, and the monsoon lands are the greatest agricultural resource left in the world. The large amount of land needed by each village when three quarters or more is always fallow results in a small population at the present time. One of the great problems facing the world is the evolution of methods of fixing these shifting cultivators, to allow an increase in population, the production of an increased surplus for sale, and at the same time to prevent soil erosion and build up the fertility of tropical soils.

It took more than the mere notion of growing crops to initiate a full system of farming. There are a few hunting tribes in the Rockies who dam some of the mountain freshets so that when swollen with the spring melt-water they flood over the flat land at the mountain foot. This encourages a plentiful growth of the wild bulbs which they gather in the autumn, a rudimentary form of agriculture without the sowing of seed. The basic implement of the agriculturist in Europe and Asia is the plough, in its simplest form a power-driven digging-stick. This implement implies a union of domestic animals and seed-sowing and its probable homeland is the 'fertile crescent', somewhere between Egypt and Iraq. This was the original home of wheat and close by the probable centre of the domestication of the ox. The horse was used for riding or for pulling a war chariot in early times, never for farm work: indeed the invention of a proper

harness so that horses could pull a plough had to wait until the Middle Ages.

Our civilization rests on plough cultivation and on domestic animals. In fig. 7 the southern boundary of the plough before the age of discovery is shown and it will be noticed that only in the East Indies does it extend south of the equator. This form of agriculture anchors peoples to the soil and it enormously increases the food supply and hence the population. Once agriculture developed in this manner, humanity began to live in permanent villages and the arts of building in stone and brick began. A surplus of food meant leisure for some and luxury for a few. Law and government became necessary in settled communities. Measurement and surveying to settle field boundary disputes between neighbours, writing and calculation, all the arts and most of the sciences, could begin only after the first plough furrow had been driven across the earth. It may be of interest to note here that the making of maps is older than writing and presumably older than agriculture. Crude but effective charts of the wave crests were prepared by the Polynesians for their voyages from island to island in the Pacific, and some tribes without knowledge of a written language made pictographs of the direction and distance apart of places they visited.

In response to soil and climate different cereals were found and used. Wheat and barley have provided bread for Europe for thousands of years; in cooler and moister parts of the continent other cereals may now be more common but the problems of cultivation remain the same. In the wetter Atlantic margins oats ripen best; while in eastern Europe with its short summers and sandy soils rye and buckwheat, originally weeds

in the wheat fields, ripen most surely. Of all the grains barley is the most versatile; it will ripen and give a good crop in the hot, dry fields of North Africa, in the mild, wet, windswept west of Ireland, or in the far north of Sweden on the Arctic Circle. Wheat, however, is everywhere preferred because it makes the best bread and under suitable conditions gives a better return for labour than any other cereal.

Europe has in reality two types of agriculture. In the south the light plough is still used as in early Egypt. This is the power-driven digging-stick, a forked branch shod with iron. North of the Alps the brown forest soils would not yield up their riches to the scratching of the light Mediterranean plough. So a heavy plough was developed, a plough that bit deep into the earth, heaved the sod up and turned it over. It required a great force, the power of four or more oxen, to pull it through the ground, and as four oxen were not every man's inheritance, we find that the North European plain from Roman times onwards was a land of large villages where people banded together to make up a plough team.

With this heavy plough, originally of wood with an iron cutting edge, European pioneers went into the new lands of the world. So long as they stayed in the forested regions this implement served them well, but it could not tackle the tough, centuries-old sod of the open grasslands. The conquest of the prairie required the steel plough and the force of many horses. Steam engines, still used on the Hungarian steppe, and latterly tractors, testify to the difficulty of cropping the grassland. With modern machinery and transportation these grassland areas are the granaries of the world. Our technical

knowledge of transport, storage, and shipping enable Canadian and Australian wheat to reach Western Europe in quantity. In the stage of evolution reached by the Romans, Britain and France played the same role as the Dominions play to-day.

Technical skill must work to limits set by physical and social conditions. We *could* grow wheat in the Arctic but only at a cost that we are not prepared to pay; we *could* crop the Sahara but again the effort is not considered worth while. Geographic limits are important, for only with great effort and by taking considerable risks can a society transgress them. American wheat growers during the 1914–18 war took the plough westwards towards the Rockies into what had been cattle-ranching country. For a few years all went well. The moisture stored up in the soil yielded a crop but disaster followed. Freed from the mat of vegetation, stirred up by deep ploughing, dry from the exhaustion of underground water by successive wheat crops, the top-soil was blown away and great dust storms ruined hundreds of square miles of the mid-western states, turning tolerable grazing lands into barren deserts.

New varieties of wheat which complete their life cycle in ninety days from the time of sowing are extending the wheat area northwards. In Canada wheat has ripened successfully in the Peace River valley (59° N.), but here again there are limits set by geographical factors. They are variable but at present the wheat lands are bounded by the lines marking ninety days free from frost and the limit of the area getting fifteen inches of rain per annum. These mark the northern and eastern limits of the wheat belt; southwards the limit is set less definitely, but as the summers become hotter and damper wheat diseases

rob the cultivator of his harvest and by the time the Ohio river is reached, wheat is replaced by maize.

The past sixty years have accomplished the expansion of man's control over the world environment. The bison has been chased from the prairie and the American Indian has followed him into reservations. The Australian blackfellow has lost his country. In Central Asia the forward march of the farmers has been more recent. Small parties of Russians had made pioneer settlements as early as 1632 but it was only in the period 1897–1911 that the peasants poured into Siberia. Under the Soviets the nomadic herders are being stabilized, and large-scale farming introduced into the Siberian black-earth region has also released many small farmers to work in modern factories. In this grain-growing area, as in North America, there are limits which, at the present level of our knowledge, cannot be forced. Over much of Central Asia the rainfall is lower and less regular than in the comparable region in North America.

Europe has considerably expanded the bases on which life rests. Industry and trade are now as important as agriculture in the north-west of that continent, and geography is often confined to the study of the world as seen through the eyes of western Europe. Some writers, for example Ellsworth Huntingdon, claim that the energy and drive of the peoples of northern Europe derive from the cool, stormy, changeable climate, but most geographers are more modest. They hold that geographical facts, such as position near the centre of the world's land-masses, abundant natural resources of soil, coal, and iron ore, availability of timber for ships and protected waters for sailing, were important; but they are willing to admit that other influences also were at

work. There have been two important civilizations in the world besides that of Europe and south-west Asia. One, the achievement of the pre-Columban Americans, has disappeared; the other is the civilization of India and China.

We need say little about the ancient Americans. They lived in high mountain country, cool and possibly energizing despite its location in the tropics. The New World is very important for the number of new crops it has given to mankind, enriching and diversifying life throughout the world. The exploitation of such opportunities was the work of Europeans: the richest farm-belt in the world to-day is the 'corn' belt of the middle U.S.A., warmer and wetter than the wheat lands, and made possible only by the native American cereal, maize or Indian corn: life in north Europe must have been difficult without the potato, a tuber from the South American Andes; the sweet potato, rapidly spreading as a food crop in the tropical lands of Africa, also comes from America. The list may be extended to include cocoa, tobacco (a drug that is almost a necessity), rubber, the tomato, and many varieties of beans.

The countries of south-east Asia where half of all humanity lives, have a monsoon climate (described in Chapter III) that makes for great seasonal vegetative growth. There life depends on the cultivation of paddy rice using the simple plough pulled by the water-buffalo. The great majority of the population clusters on the hot steaming river plains and deltas. This form of rice is a most exacting crop. It grows in water and rice fields must be kept flooded during the growing season. The seed is sown in a small nursery and the seedlings transplanted by hand to their permanent quarters. During

the whole process of growth the amount of water in the field must be carefully regulated; too much water will drown the young plants, too little will cause wilting. Under the warm constant rains the harvest may be gathered in about four months, so rapid is growth and maturing. In the warmest parts three crops in a year may be taken from the same field.

The segment of Asia from the Ganges to the Yangtze and south Japan is not uniformly suitable for rice cultivation. It has been estimated that less than one-third of the acreage of China that could be cultivated is under crop. The necessity for flood water concentrates the population on the flat valley floors; as population increases the people push out into the deltas where land and sea are struggling for mastery, and from boats, tubs, or even earthenware pots they take possession of every mud-bank that appears above the water. The rice fields feed a teeming mass of people, more than 1,000 to the square mile, a density reached in other parts of the world only by such tight-packed industrial countries as Belgium. Irrigation canals extend the influence of the rivers throughout their flood-plains, smaller streams are trapped on the edge of the level land and directed across sloping terraces to the main channel.

In contrast to the struggle for land in the rainy and flat river beds, the hill slopes are often left untouched. In India they harbour jungle tribes, sometimes of primitive slash-and-burn agriculturists and occasionally of collectors. Rice is grown wherever possible as it supports the greatest number of people per acre and as its grains keep better than any other in the hot, damp atmosphere. Wherever rainfall drops below 40 inches per annum in India, and in areas of porous soils even with that amount

of rainfall, irrigation becomes difficult and rice is replaced by other grains. Millet and kaoliang are dry-area crops which will yield a return wherever rain is short or uncertain, as on the Deccan of India or in Shantung in China. In the western parts of India, the upper Indus or the Punjab, and in the Hwangho river basin of China wheat is important. Not only is the climate suitable but these two areas have had more contacts in the past with lands beyond the mountains, with civilizations based on wheat. Into the Punjab came early farmers from Iraq and a corresponding migration seems also to have taken these people across central Asia to Kansu province in China.

This chapter, with its accounts of early peoples and of the 'vegetable' civilization of south-east Asia, is an essential bridge between the accounts of the physical environment and the interpretation of man in the world to-day. The emphasis of all modern geographical studies has been placed on the relationship of man to his environment. Without some knowledge of the simpler societies, as shown in fig. 7, and of the past it is impossible fully to see the position of man in the world to-day. The principal geographical characteristic of all these societies is their limitation to a particular part of the world and their need to subsist off the local landscape. In some cases the concentration into a particular type of habitat, as in the case of the hunting and collecting groups, is due to their being crowded out from desirable localities by societies able to make a better use of the country. The world distribution of the gatherers at the ends of the earth shows that they once occupied all types of land and all environments in the world. This conclusion from the distribution map is confirmed by the archaeologists, who

tell us that all human groups were hunters and collectors during the Old Stone Age and that before that stage was passed traces of human occupation have been found in all the continents.

Peoples at the stage of subsistence agriculture have adapted themselves closely to many different types of landscape and to many varieties of soil and climate. The geographical centre from which the discovery of agriculture diffused throughout the Old World seems to have been the Near East, important then as now as a meeting place of peoples. The axe, and its near relative the pick or hoe, subdued the primeval forest and they are still agricultural tools in hill lands not wanted by other peoples. Few farmers have successfully farmed hill slopes. In south China and the East Indies flat rice lands are small and very crowded, so farmers terrace the hill sides into tiny, walled fields each of which holds back some of the precious flood-water. These constructions are marvels of engineering and it is only at infrequent intervals that the weight of soil and water disturbs one of the retaining walls and a hillside is swept bare of terraces, sloughing off the labour of centuries in a few hours. The conquest of the sloping land—and there is a lot of hill slope in the world—has been achieved in a more gentle fashion by submission to its peculiar conditions. In western Europe this means leaving steep slopes to grass and grazing animals, and in the Mediterranean the cultivation of tree crops such as the olive, the orange, the lemon and the vine often on terraces.

Farmers prefer flat land, not necessarily absolutely flat, of course, but gentle slopes of up to 1 in 10 are here included with the flat land. Rice cultivators cling to the level monsoonal river deltas and generally neglect slopes.

Wheat farmers like rolling country, and the invention of new implements and power machinery gave them the impetus to conquer the gently rolling grasslands. We can thus see three widely separated civilizations of farmers growing up. Human invention adapted to the terrain of the broad-leaved, temperate forests of Europe taking its heavy traction plough into the interior, black-soil grasslands of all the continents. The buffalo-drawn, mud-stirring plough of the rice lands has tamed the valleys of the Far East and the East Indian archipelago. The third important group are the hoe users of Africa, the women stirring the ashes of the bush cut and fired by the men. They are inefficient only in the sense that they must work on a small scale, each family requiring much fallow land for every acre under crop. American native agriculture has been almost completely disrupted by conquest, except in those areas of South America not yet settled intensively by white men. Of the original slash-and-burn agriculturists only a few scattered remnants survive in the Old World on the fringes of the more advanced cultures.

Farmers have never been able to settle and exploit the vast areas of the pine forest in northern latitudes. Its short precarious summers and cold grey infertile soils have been left to the trapper. The farmers also leave the deserts to the nomad, taking only those desirable spots where water is plentiful, the oases and the banks of exotic rivers such as the Nile, the Euphrates, or the Indus.

Only the modern civilization of the north Atlantic makes use of every type of landscape in the world. Frequently wasteful and destructive of natural resources, its command of transport by land and sea enables it to accumulate products from every climate and every

continent. It is important, however, not to be blinded by the power and penetration of this society. Geography of all subjects ought to enable the student to see the world as it is in reality and the facts are indisputable. Over most of the surface of the earth and for a majority of the world's peoples, in Europe as in Asia, the older way of life, the life of the farms and the small villages, is supremely important. Conservative, narrow in outlook, slow to change, it represents the tried and true in a world of shifting values; we may say that they have cultivated the land and fed their families for centuries, without disastrous consequences. The new world of experiment and change may mean a richer life but it raises enormous problems, problems for geography as for every other science. In the next chapter we shall try to approach, through a description of the industrial lands, some of these problems.

CHAPTER V

THE EXTENSION OF THE ENVIRONMENT

To the geographer no people are so primitive that they do not possess a culture that can be classified and its position in the world compared with and related to that of other cultures. Most of the people mentioned in the last chapter, and all mankind until a couple of centuries ago, gained their living from the surface of the earth's crust. Small adit mines and moderately deep wells had made tentative explorations; but the vast stores of mineral wealth that lay hidden remained untouched until, with the use of mechanical energy, there came a vast expansion in man's demands upon his environment. His mines sunk their shafts for ores a mile deep in the crust and his oil wells ground deeper and deeper yet. And with this vertical expansion that was soon to be carried upwards to the stratosphere, there came a great horizontal spread across the face of the earth resting upon a growing web of transport over both land and sea. Along its lines man hastens in his restless journeyings between the great concentrations of population that this industrial age has gathered together to form a strange new pattern upon the face of the earth. This dynamic impulse is more than mere cause and effect, it is a complex entity affecting all lands and all peoples. In this chapter we shall study the geographic determinants behind the rise of industrial civilization and the geographic controls that have governed its expansion.

This conquest of the world, and more particularly of

the underworld with all its vast mineral wealth and potential industrial power, has been the work of one particular group of people living in one particular corner of the inhabited globe, the west Europeans. They have spread across the ocean and taken their familiar cultural patterns with them to set up a similar way of life in the eastern United States. And there with the acquisition of new energy they penetrated deeper into the crust and took their conquest of time and space a stage further. Their influence soon spread over the entire world, changing, almost imperceptibly at first, all other civilizations by the merest contact. Only the monsoon lands have resisted attempts to be incorporated within their political rule. The pervasive nature of this civilization must raise the question: 'Did the fact that these men were located primarily in west Europe have any influence upon their ultimate conquest of the whole earth?'

Before we can consider that problem the social geography of an industrial area must be given.

The geographical factors in the development of industries are quite clear. The whole structure rests on hollow foundations, deep shafts sunk to the coal beds, which are burrowed out laterally beneath in all directions as far as the carboniferous layers extend. A map of the coalfields gives the distribution of the major industrial areas. In Great Britain at the beginning of the process of industrialization the population drifted northwards from the English plain to the coalfields, there to concentrate and multiply and extend again to form a close network over the flanks of the Pennines, the areas of older rocks in the Midlands, and around the edges of the Welsh mountains. The towns which grew up and which house the majority of the English people to-day differ remarkably from

the quiet market and cathedral towns of the agricultural areas of south-east England. It is often a cause of lamentation that they do not fit so easily into the landscape. Southern England is a man-made landscape as much as the industrial areas: the bare Downs would be covered with scrub if it were not for the sheep but the towns in the south reflect the former preoccupation of the population with agriculture and trade; they are of slow growth and seem to us part of the countryside.

Industrial towns also reflect the attachment of the people to the land. The methods and ends are different, mining shafts and headgear, factory buildings and tall chimneys, transport by rail, canal, and road are as vital to this form of society as are the market square and the open fields to the farming community. The towns may indeed be rather less beautiful than they could have been but that is not the point. Depending on mining, burning vast quantities of coal, selling machine-made products in the markets of the world, they had to give prominence to the things that mattered and were bound to differ from the traditional town pattern.

It is difficult to be dogmatic on matters of divided opinion such as this; generalizations come as slowly to a geographer as to any other scientist. Indeed, science is in essence merely a careful way of generalizing and of avoiding the facile correlations of much of everyday life. Much of this book has perforce to consist of conclusions rather than of the long struggle with many facts that preceded them. It is possible to discover a great many similarities between the areas of concentration of modern industry, but each one has a character and personality distinguishing it from all others; Lancashire differs from Yorkshire and both differ from the Midlands or the

central valley of Scotland. This is not only because they produce, in the main, products that are turned out from buildings of distinctive architecture. It is also because they are different geographical areas with an historical past that gives an individuality. In the long run, however, the underlying similarities are probably more important, and are certainly more fundamental, to an understanding of an industrial area.

The close concentration of our industrial regions around the major coal-mining seams is a reflection of the historical sequence in which the locomotive and the railway did not develop until towards the end of the Industrial Revolution. Between 1770 and 1840 difficulties of transport for coal and coke meant that the factories, developed around the steam engine, kept to within a convenient distance of their sources of power. The impetus to development was strongest in those areas where earlier water-power mills could be replaced by steam-power plants. In those circumstances the skilled workers had not to change their place of living, a great advantage for the building up of a labour force skilled in factory work and in the regular hours which industry requires is much slower than the process of erecting the buildings or installing the machines.

In south Lancashire, for example, the cotton manufacture grew up from a former woollen craft industry scattered in cottage homes over the countryside. Cotton had been imported from the eastern Mediterranean at an early date and mixed with local woollen warp to produce various types of mixed cloths. The skills did not develop in a vacuum; contact with the Low Countries and the immigration of skilled Flemish weavers stimulated the native artisans. In hand-work days other

regions of Britain had as much of the cotton textile industry as south Lancashire, so that the advantages of the terrain must be adduced cautiously if we wish to assert that geographical factors were of early importance in the location of the industry. Soft water from the Millstone Grit and the Coal Measures, a necessary requirement for washing the raw materials and finished goods, is as common in other places as in the modern zone of concentration. Textile manufacturing remained in south Lancashire, however, not because any single local factor was supremely important but because each new development as it arose could be fitted into the region, and there was a continuing tradition amongst its people of skill in the handling of yarn. Thus the swift-flowing streams of the narrow valleys in the coal-measure rocks drove the early water mills which succeeded the cottage industry. At the change-over to the steam engine, coal was found on the spot.

Lancashire was fortunate, too, in its access to water and to water transport. One of the great drawbacks of early Manchester was the lack of good roads. Built on clay, separated from the Mersey estuary by the wide Chat Moss, it was difficult to move in the seventeenth century even with a packhorse load on the wet, winter roads. Manchester was one of the earliest centres of canal building and by 1720 was dredging the Irwell and improving its communications with the Mersey. Liverpool, the port serving the cotton area, dug its first dock in 1715 but the advantages of its situation were not fully appreciated until the last decade of the eighteenth century when American cotton began to pour across the Atlantic. Port facilities became more and more important to the cotton textile manufacturer not only because

his raw material is imported but also because saturation of the home market led to the search for new markets for the finished webs beyond the British Isles.

As well as finding soft water, river power, and coal in close proximity to one another, the Lancashire cotton manufacturer had signal advantages of situation when in the years following 1785 chemical bleaching began to be introduced. The raw materials required by the new process could most easily be assembled in the middle Mersey, between the port of Liverpool and the cotton centre at Manchester. Salt came from the Cheshire mines a few miles away and sulphur was imported from the Mediterranean as a return cargo for textile exports. The heavy chemical industry of Widnes and Runcorn has developed on its own and in its expansion has outstripped the needs of the local mills, so that it now serves a world market.

The pool of active and willing people in south Lancashire contributed by its inventions and energy to the development of the chemical industry. As new imports have become available, the factories have branched out into many strange products such as explosives, fertilizers, dye-stuffs, food products and, using vegetable oils from tropical lands, soap and margarine. A further ancillary industry is engineering. This began with the simple mechanical inventions of the more enterprising domestic workers which were to transform the whole aspect of the industry. To-day the Manchester area is one of the world's major engineering provinces, making and exporting not only textile machinery, electrical and transport equipment, but every other known type of machine, large and small. This industry seems to have developed mainly because of the concentration of

population with a demand for such goods and of the fine transport network, for there is no local smelting of iron and steel.

The landscape resulting from this industrial node is very different from that of any other type of civilization. The large town, dominated by mill chimneys, contrasts with the market place and cathedral spire of the agricultural centres of the rich farming areas. The industrial region has, as we have said, influenced the relationship of man to the land in almost every part of the world.

Before we leave this Lancashire region some other of its more immediate effects must be noted. In the world to-day south Lancashire as a producer of industrial products is probably the most highly specialized area. Spinning is concentrated in the towns (larger than many cities of purely agricultural countries) within reach of Manchester. Weaving is a more widespread activity, penetrating north of the Rossendale anticline to the Ribble valley and its tributaries. Part of the reason for this is economic; there are more varieties of weave than counts of yarn and so the average size of the mill tends to be smaller, the units more flexible and more easily dispersed. The same consideration may help to explain the even smaller size of the average garment-making shop and its even wider dispersal. Lancashire has not taken kindly to this type of finishing, influenced strongly by fashion changes and by different markets for every country and for many economic levels within each country. Ready-to-wear cotton shirts, dresses, aprons, etc., are specialities of places within the British Isles as far apart as London and Londonderry.

In addition to the development of canals, railways, and roads, the large population concentration has

important repercussions on the surrounding rural areas. It provides a market for milk and vegetables and encourages intensive cultivation. The growers find it worth while to go to great trouble in countering geographical difficulties by the erection of glasshouses and by research on seeds, fertilizers, and methods of husbandry. These crops are grown, it should be remembered, in a county that is north of 53° N. latitude. Poultry and pigs, fed in part on urban swill, are typical of the livestock population of the rural parts of Lancashire; there are more poultry in Lancashire than in any other county in Britain. Despite this intensive agriculture the greater part of the food for the town dwellers is imported, and in every large centre of population there is an important ancillary industry of food preparation. Pre-cooked foods in packages, sauces, pickles, beer, and other beverages are all by-products of urban life, found not only in Lancashire but in all other industrial areas. The pull of the towns is also shown by the distribution of the fishing ports, Fleetwood in Lancs., Grimsby serving Yorkshire and the Midlands, Milford Haven for South Wales, Lowestoft and Yarmouth convenient to the London area and so on, for the destiny of the major portion of the white fish landed is to be joined in a packet with chips to make a tasty and nutritious supper.

In its later developments, too, industrialism allows more and more freedom to the worker. The geographic impact of this can be seen in the rise of the holiday town, a place almost unknown before the railway made passenger travel fast and comfortable. The population of the industrial towns of northern England created Blackpool and the north Wales resorts where mass entertainments by the seaside are provided. The need for

relaxation, no less than the need for drinking water, has led to changes in the Lake District, the Pennines, and the isolated Welsh mountains.

The transformation of considerable areas of Great Britain through the growth of large urban populations based on manufacturing industries involves many changes not mentioned here. The ramifications are legion and to attempt to encompass them would involve a discussion of the whole of contemporary life. The geographic aspects of the modern world are so many-sided that we must choose those that are 'basic' or 'important' and use them to generalize about the complex life of an industrial region. Thus Lancashire, because it employs over 80 per cent. of all cotton textile operatives, is usually spoken of as the 'cotton' region. In the same way Yorkshire is the 'woollen' region, the Black Country is 'noted for' non-ferrous metals (brass, aluminium, etc.), light engineering, and small-scale iron and steel goods. Each region is in fact a complicated hub of industry producing some standard articles in quantity but also producing other products in great variety.

Geographical generalizations of necessity direct attention to the characteristic manufactures, and in any close regional study the making of such general statements is, as we have said, a matter that calls for careful weighing of the evidence and for cautious wording. The short discussion of south Lancashire has given a glimpse of the difficulties and, as we turn our attention to the process of industrialization with the world as a background, the general picture should be qualified by an appreciation of the complicated interactions that make up human experience in any such region.

Our example, Lancashire, shows that the genesis of an industrial region must be sought far back in history. At the outset trade and transport were more important than mining. Indeed, the development of industry depended as much on sea transport as on mining. A premature development took place in the calm Norwegian fjords where by A.D. 500 the Vikings had perfected the sea-going rowing boat, but the progressive conquest of the oceans began in the quiet waters of the Mediterranean. A square sail was fitted, but these boats were shallow and oars had to be used unless the wind was astern. In a similar geographical relationship to the Mediterranean, but south-east instead of north-west, the Arabs evolved the lateen sailing rig for ocean travel, a more successful rig than that of the Northmen and one still in use to-day by dhows, Malayan praus, and many other native craft of the South Seas. The lateen sail brought the compass from China, and in the western Mediterranean the final conquest of the ocean was begun with the square-rigged ship, probably originated by the Portuguese, equipped with the compass and other primitive navigational aids.

The sea is vastly superior to the land as a medium of travel. Once the devices for navigation are known (the ship, the compass, and, much later, the chronometer) man may journey by sea to most parts of the world. The fact that 72 per cent. of the surface of the globe is salt water makes this possible. On the sea, too, there is none of the difficulty of land travel, friction is less, slope is uniform (if we except the hazards of storms), there are no mountain ranges to impede journeying in any direction, and the extremes of heat and cold are less than on land. The operation of a ship instils discipline and obedience as much as the organization of a herding band.

One drawback of the ocean is its great size; voyages by sea are usually longer than on land but the greater distances are offset by the superiority of the medium. One horsepower will draw 3,000 lb. by road, 30,000 on a railway, and 200,000 on a waterway.

Because of the efficiency of transport by sea most industrial areas were situated in the first instance on coalfields that were close by a port site. This geographic factor gave Great Britain an initial start in the process of industrialization that has not yet been lost. Inland industrial areas tended to develop near navigable rivers or in flat country where canal construction was not hampered by the necessity to build many locks.

Coal measures are found in areas of old rocks which were not generally areas of important settlement in pre-industrial days. In Great Britain they occur north and west of a line joining the mouth of the Tees and the mouth of the Exe; this line of division between highland Britain and lowland Britain, between soils of low fertility and steep slopes and rich clays and loams of gentle slopes, is a significant divide in the historical geography of the island. On the continent of Europe coal tends to be found at intervals or 'bays' on the northward margins of the Hercynian fold mountains. Hence we find industrial areas based on coal in north France and Belgium on the flanks of the Ardennes, in the Ruhr valley, in Saxony, in Bohemia, and in Silesian Poland. In Europe this foothill zone has been a corridor of movement for centuries and many important fairs had grown up by medieval times in the towns along it. Civic pride has helped many, such as Leipzig or Dresden, to absorb industrialism and modify its essential ugliness. On the coalfield of the Ruhr valley, on the other hand,

the industrial towns might be in northern England; they have no long tradition of city life.

For a centre of heavy industry to develop large deposits of iron ore and large quantities of coal suitable for metallurgical purposes must be available. It is rare for these two primary essentials to be found together. In general the plant and the reserve of skilled workers have developed on the coalfield, often using supplies of ore that were soon to be exhausted. So that for large-scale modern working in the world to-day a third necessity is transport. In addition technical changes which allow the use of ores formerly difficult to smelt and which alter the relative importance of the separate elements within the industry, are constantly changing the purely geographic factors in the location of iron and steel plants. Thus the change to the controlled coke-oven favoured the movement of the coking process to the side of the blast furnace; formerly coke had come long distances from the older open ovens by rail because it is lighter in weight than coal.

In north-west Europe the heavy iron and steel plants were originally placed on the coalfields and the skill of the workers coupled with the capital invested have discouraged movement to new sites, so the ore still travels for the most part to the coalfield. Ore flows to Great Britain from the north Swedish mines, from Spain and north Africa. None of these areas has developed a large-scale iron smelting industry. On the Continent the great ore masses of Lorraine move by barge and railway towards the Ruhr, the Saar, and the Franco-Belgian industrial area. Movements of heavy cargoes by rail is more expensive than by sea, and a return freight almost equal in bulk is a necessity. Thus both the iron fields

and the coalfields develop blast furnaces and steel converters. Seaborne ore has caused the movement of some steel plant from the exhausted local supplies of the upland valleys to the ports in South Wales to avoid the extra cost of the uphill pull of the heavy ore trains.

The full development of these geographical influences can best be seen in the continental spaces of the U.S.A. and the U.S.S.R. The original focus of the steel industry of the U.S.A. was on the Pennsylvanian coalfield around Pittsburg, and this is still the most important producing region in the country, turning out more than one third of the total product. Vast new deposits of iron ore at the western end of Lake Superior were found and exploited. After 1900 a secondary line of blast furnaces grew up at the ports which received this ore on the southern shore of Lake Erie. On the Great Lakes a fleet of boats emerged fitted out specially for the transport of the ore. Freight trains to Pennsylvania taking the raw material could return filled with coal for the new lakeside plants. The more recent establishment of a great new industrial giant at Gary on the southern tip of Lake Michigan marks another stage in the evolution of the industry. The ores still arrive from Lake Superior by ship; the journey is no shorter than to Cleveland and other Ohio ports. Much of the coal used at Gary still comes by rail from the Appalachians, as the coal of Illinois and Indiana is not good for smelting. We must interpret this development in the light of a move towards the expanding market for steel and steel products in the growing cities of the Middle West, a shift that has been successful, for Illinois-Indiana increased its output from 12 per cent. of the U.S.A. total in 1902 to 20 per cent. in 1929. In all this, however, the ore has

moved to the plant which has been situated at a point where coal and raw materials could be conveniently brought together. In the same way the conveyance of overseas ores from Cuba and Chile has established new producing areas on the Atlantic coast of the U.S.A., e.g. at Sparrow's Point on the Delaware River.

The Great Lakes form an important highway for the movement of bulky products within North America. By speeding up ships, by quick methods of loading and unloading, the disadvantage of the four months' freeze-up of navigation is overcome. No such body of water was available to the U.S.S.R. in establishing the trans-Ural heavy industry. Faced by a separation of 1,250 miles of land between the best known supplies of iron ore and coking coal, the Soviets decided to erect furnaces at both ends of the railway link; they shuttled coal or coke from the Kuzbas coal basin in the valley of the Tom to the Magnitogorsk ores in the Urals and took back iron ore. Magnitogorsk was built up in ten years from a village to a 1939 population of 145,870, and at the eastern terminus, fed by the ores from this area, the complementary combine grew at a similar rate. The grave disadvantages of this layout, disadvantages which stem from the local geography, became apparent as the two centres grew, and especially as railway rolling stock became strained by wartime demands. Local ores of lower quality began to be used in the Kuzbas zone and great efforts were made to use nearby coal deposits in the Urals and from the Karaganda coalfield on the Kazak steppe. A water route on a wide lake or on the sea has potentially a much greater carrying capacity than any railway. The rivers of the trans-Ural country have not given any help to the Soviets, for they flow

in general northwards to the Arctic Ocean and are subject to great fluctuations in water level, especially in summer.

We have seen that the basic layer of modern civilization—coal mining and iron production—tends towards concentration in areas of abundant supplies, that it depends on transport for which it supplies the rails, steel plates, locomotives and rolling stock, and that the concentration in larger and larger units at places of abundant and easily obtained coal and iron is a characteristic of the modern world (fig. 10). Other sources of power are secondary to these. Oil fields in the mid-west of the U.S.A., in Iraq, or in the Caspian area export their product in pipes or tanker ships. Oil is a more typical extractive industry than coal, for supplies tend to be quickly exhausted and the field abandoned. Few oil fields have given rise to industrial concentrations; the major exception is the Californian field on the Pacific coast of the U.S.A. where no coal is available.

As in the case of the oil industry, the development of hydro-electric power in the past fifty years has not yet caused any decline in the older industrial areas. In fact the mountain-foot zone, with industries and transport using electricity, remains to a large extent subsidiary to the major areas based on the coalfields. It specializes in small easily transported products, the construction of which requires a maximum of skilled labour and a minimum of raw material. Cameras, clocks, small and intricate instruments like calculating machines, are typical products of Switzerland or Sweden. More obviously subsidiary to established industrial zones is the preparation by electrical processes of fertilizer, chemicals, explosives, and aluminium, characteristic of Norway and the Tennessee valley of the United States.

Raw materials stream across the oceans to the ports of the industrial areas around the North Sea and the eastern coasts of the U.S.A. from all parts of the world. We have mentioned the import of iron ore from Chile and Africa, and in truth it may be said that the industrial areas influence the production of all the earth. For them cotton is grown in vast quantities in the southern states of the U.S.A., in Egypt, in African colonies, and in India. To feed their townspeople they require the grains produced on the virgin soils of the newly exploited grasslands of the Americas and Australia, and only this form of civilization could transport it over the distances involved. Even to-day, however, the difficulties of land transport, its higher friction, and the consequent effort required to move a load, mean that wheat grown more than twenty miles from a railway is difficult to market economically. So large stretches of the grasslands remain as stock ranches; some are too dry ever to grow crops but others will be turned to arable once the railway reaches them.

Crops for the industrial lands have begun to break down the former self-sufficiency of the tropical forests. Huge acreages of rubber plantations have transformed the face of Malaya; oil palms and cocoa groves exist side by side with the native subsistence crops of yams, cassava, and plantains in West Africa. The areas in the equatorial lands exploited by these new crops have been those most accessible by sea or river, as for example the East Indies where the forest is broken up by islands, or West Africa where much of the primeval tall rain forest had already been cut over by slash-and-burn native cultivators.

The geography of the world to-day must recognize the

plantation agriculture of the equatorial lands as a product of the society of western Europe. Other natural areas have also been affected. The traditional areas of tree crops, the hilly Mediterranean lands, now produce fruits and delicacies for the industrial town. The application of modern transport has allowed the lands of similar climate in the southern hemisphere to send the same type of product and, as their summer corresponds to winter in the northern hemisphere, we enjoy this fruit at a time of the year when the harvest of the northern lands has already been consumed. The citrus family, oranges, lemons, grapefruit, and limes are most important. Other crops include the grape, either as wine or dried as currants, sultanas or raisins, and the olive. California, the Cape Province, and Australia all compete in these markets. The mediterranean zone of Chile, centred on Valparaiso, is an important producer of wine but its products rarely appear in Great Britain. The only fruit from tropical lands that reaches us in quantity is the banana, but there are many others such as the mango and the durian that may come in time.

When describing the production of the hillside crops we must not forget the two most propular drinks of these industrial lands, tea and coffee. They have replaced on the breakfast table the traditional drinks of the agricultural peoples of Europe, beer, cider, or wine. Both come from small trees that flourish best in monsoonal lands. They like heavy rainfall, heat but not direct sunshine, and although they demand a lot of water they also require good soil drainage. Tea and coffee planters also require a dry season in which to dry the leaves or beans. The plantations are situated on the hill slopes of the wetter monsoon lands, where the slope provides a

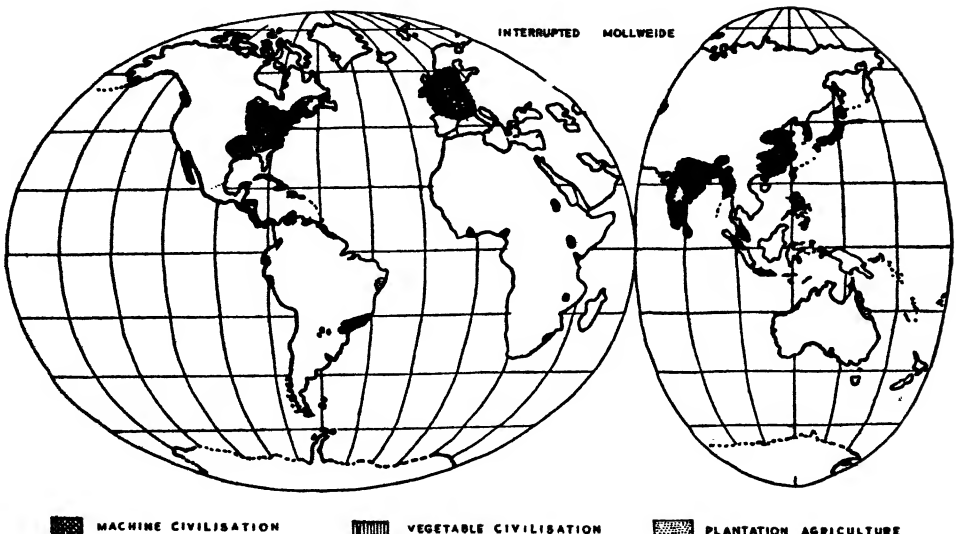

Fig. 10. SOME MODERN SOCIAL GROUPS.

natural run-off and where the rainless season facilitates drying. Tea from India, Ceylon, and China has become the main drink of the English-speaking peoples, who first obtained it by sea, and of the peoples of Central Asia and Russia who had contacts by the overland route with both India and China. Coffee, made from the berries of a similar shrub, is the principal drink of many continental countries and of the U.S.A. It is one example of a geographic movement of the main area of cultivation from the Old World to the New for, although a native of Abyssinia, 94 per cent. of the world's production of coffee comes from the New World, 70 per cent. from Brazil. In no other area are the geographical conditions so well suited to coffee over so large an area as in the hilly hinterland of Santos and Rio de Janeiro; the soil is rich and fertile, the hill slopes permit of good air and ground drainage, the rainfall is ample, and there is a dry season when the beans may be spread out on the valley floors before shipment.

These industrial lands hunger not only for food crops and commercial fibres but also for exotic minerals. Aluminium has already been mentioned, but others are also of great importance. If Europe has passed through a bronze age and an iron age it is now in an age of compound metals when steel is tempered for many specialized uses by the addition of small quantities of other elements such as nickel, tungsten, vanadium, or chrome. Mining is always a destructive activity, it takes away but never replaces, and consequently mining areas, like oilfields, are often deserted once the cause of the settlement is exhausted. The mining camp generally has a temporary appearance and a shifting population. Mining is, however, one way of making use of parts of

the earth that are unsuitable for agriculture, and a rich deposit permits settlement for many years in even the most inhospitable environment. The luxury products, gold and precious stones, attract most popular attention, and for the gold-mining camps of Kalgoorlie and Coolgardie in the Western Australian desert the water supply has to be piped 200 miles. Minerals, as has been stated in Chapter II, tend to occur in old rock-masses, on the edge of those stable shields which are the oldest land above the surface. Copper mines now operate on the fringes of the rain forest in the Katanga district of the Belgian Congo, nickel for steel hardening is mined in the inhospitable Canadian shield at Sudbury, complex ores of the silver-lead-zinc group in the desert state of Nevada. Rich supplies of ores attract the white engineer and have made settlements possible both in the desert lands and in the northern pine forest zone. Norway even operates a coal mine in Spitzbergen at 75° north; and the major source of cryolite, a substance necessary to the electrolytic smelting of aluminium, is in Greenland. Metal ores are not the only substances sought; in Chile the nitrate salts in the dried lake-beds of the Atacama desert are dug and dispatched under great difficulties from a cliff coastline. Water was carried there in special tankers before a pipe line was made from the Andes streams, and in the early days so barren was the landscape on one of the mining stations that the golf course had to have imitation trees with green painted metal leaves to break the hot glare of the desert sun.

Not very different from mining is the exploitation of the coniferous forest zone. Destructive lumbering in the past has stripped the U.S.A. of most of its own resources, and the pine wood required by that country is now

brought from Canada. Euro-American peoples make use of this environment for the extraction of minerals, furs, and timber. Life there is difficult but with the knowledge of building and heating that we possess the rigours of the long winter can probably be faced better than the trials of the hot steamy tropics. Softwood timber has still many uses in our cities; it supplies paper, artificial silk, and cellulose, as well as fulfilling its more orthodox functions in building and furniture making.

So important is this aspect of the modern world that the study of economic geography is a highly specialized branch of our subject. It makes considerable use of distribution maps and tries to explain the reasons for the major areas of world production of any particular commodity in terms of physical and social geography. We may illustrate these principles in more detail than was possible above by studying the world distribution of sugar production. The table below gives the production by countries as percentages of the world total for both cane sugar and beet sugar. These two crops are quite distinct in their growing requirements and are consequently produced in widely differing environments, a fact clearly demonstrated by fig. 11. It will be well to treat of each separately.

CANE SUGAR		BEET SUGAR	
Percentages of world production, average of years 1930–35			
Caribbean area	22	Germany	11
East Indies and South-west Pacific	19	France	4
India	12	Poland	4
Hawaii	3	Russia	5
South America	6	Britain	1
Australia, South Africa, etc.	5	Rest of Europe	5
		U.S.A.	3
Total cane sugar	67%	*Total beet sugar*	33%

The sugar cane is a type of grass which is grown for its juicy stems and propagated by cuttings rather than seed. Although naturally a perennial, under cultivation the roots are ploughed up either yearly or after two years and a fresh crop planted. Like all tropical tall grasses it makes very rapid growth until it is 6 to 12 feet high and to do this it needs a good deep soil, rich in nitrates. It cannot withstand frost and consequently the U.S.A., where winter frosts sweep occasionally as far south as Florida, grows hardly any sugar cane. The plant also needs abundant moisture, 60 inches of rain per annum at least, and ample sunshine at the ripening season, otherwise the deposition of sugar in the stems is slowed down. The cut canes are very heavy, and extraction is usually undertaken in crushing-mills near the cane fields; light railways often supplement the more normal methods of field transport. For economic sale the crop requires much hand labour in harvesting and in the preliminary processing, so there must be a numerous and cheap labour force. Cheap transport is also necessary to get the sugar to its final market. Few parts of the world satisfy all these conditions—tropical, frost-free climate with a marked dry spell, deep fertile soils, abundant labour not occupied with getting mere subsistence, and ease of shipping. They are fulfilled in the West Indian islands, the island of Java, the Philippines, and Hawaii, and, as the above table shows, all these places produce significant amounts of sugar. Unfortunately most of them are also in the tornado or hurricane belts of the world, and that forms an additional hazard to the normal ones of growing and selling a product on a fluctuating world-market. The third country on the list of producers, India, is not usually thought of as a supplier of

sugar. Although the original home of the plant, India, far from being an exporter, is in fact an importer. As a watery syrup (the '*gur*' of su-gar) it is universally used in that subcontinent as a delicacy. So it is with many crops—the major growers are not suppliers of the world-market. India and China grow most rice, but both import from such countries as Burma or Siam which, while they grow lesser amounts of the grain, have a much smaller population and a surplus to export. In

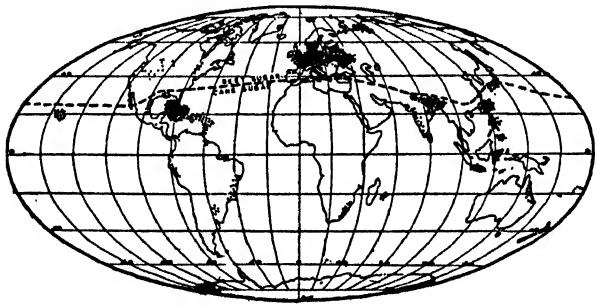

Fig. 11. WORLD SUGAR PRODUCTION.

economic geography most emphasis is placed on production for a market, a market provided by and dominated by the machine civilizations of the north Atlantic.

The rival source of sugar, white beet, is no real competitor to cane. Acre for acre the sugar beets, products of the cool temperate Europe, cannot ever hope to give more than half the yield of sugar cane, and cane moreover requires less attention and less elaborate machinery. Yet cane sugar was gradually being driven off the European market in the years preceding 1939. The geographic factors all seemed to favour cane as a world-source of sugar, but economic reasons gave place to

political expediency. Sugar is important for many products and has become almost a necessity in the diet of western Europe. The nation states wanted to have the sugar supply within their own control, so immense stores of time, energy, and money were expended to that end. White beet as a source of sweet sap was tried experimentally in Germany as early as 1747. Although it contained less than 5 per cent. of sugar content it proved its usefulness during the Napoleonic struggle. All through the nineteenth century plant-breeders improved the qualities of the roots. To-day sugar beet has a sugar content of 16 per cent., and the weight of beet lifted per acre increased from 1,636 lb. in 1850 to 4,048 lb. in 1910. Despite these improvements, and they constitute a magnificent example of the triumph of human will in conquering obstacles that are largely geographical, the most efficiently organized production of sugar from beet could not compete in price with sugar produced from the naturally endowed, and generally inefficiently cultivated, cane without tariff protection from governments.

In Europe—and Europe produces 85 per cent. of the world's output of beet sugar—the crop competes for land with the potato, an essential food. The growing, harvesting, and carting of the beet to the factories absorb large amounts of labour, and the expensive equipment of the factories can run only for a few months of the year. However, they use a non-specialist labour force and work in the slack season of farming and thus help with some pressing problems of rural under-employment. It is this aspect of beet cultivation, its ability to fit into the mixed farming rotation of the north European plain and its use of manpower from the small farms, together with the

fact that the tops and the pulp are valuable stock feed, that strengthens its appeal to autarchic governments, an appeal originally founded on self-sufficiency.

These statements, partly geographical, partly economic, partly political, are necessary to explain the simple geographical distribution in fig. 11. Economic geography has a wide field to study and a wide range of factors to weigh before it can expound the reasons for the world-distribution of any product. Climate, soils, the labour requirements, the ease of transport to the sea coast, social or political factors such as tariffs or frontiers, all must be taken into account in the light of the special needs of each product. Many minerals are so localized that, if wanted, they can be transported over great distances, but, as in the case of agricultural crops, each is in a special category and in many instances the distance of the deposit from the coast or a navigable waterway is decisive.

In the geography of the world's market the web of communications that unites all areas of the globe is very important. Sea transport extends from the coastwise shipping of the narrow seas over all the oceans. The most important ocean thoroughfare is that across the north Atlantic, linking the north-west of Europe with the granaries and cotton fields of North America and at the same time exchanging the industrial products of Europe and the U.S.A. That is one aspect of sea trade; other routes cross the equator joining the southern continents with Europe and America. The freight on all these journeys is machine products outwards from Europe and the products of the temperate lands, wheat, refrigerated meat, and fruit inwards. Additional sea routes exchange the products of tropical lands for

industrial goods: bananas and oil from the Caribbean, coffee from Brazil, cocoa, palm oil, and ground nuts from West Africa, and rubber and tin from Malaya. The sea lanes converge on the great canals, human achievements that have had profound effects on the transport of the world.

The Suez Canal, a sea-level trench 100 miles long connecting the Red Sea and the Mediterranean, is a major artery of British trade. Completed in 1869, it transformed the journey to India and the Far East as well as bringing the Mediterranean back again as a pivot of world trade. The Suez Canal dealt a death blow to the sailing ship; the winds in the Red Sea and in the Mediterranean were not regular enough in the proper quarters for them to compete. In terms of world geography it may be considered to have opened up what is virtually a coastwise route around the greatest island in the world, Eurasia. Coal is available at both ends, either in north-west Europe or in Japan, and is also piled up at coaling stations *en route*, at Gibraltar, Malta, Port Said, and Aden. The main artery of traffic is fed by many branches from the Adriatic and the Black Sea to the Yellow Sea.

Strategically, as we shall see in the next chapter, the route to India and the Far East is an important lifeline in the British Empire. The alternative seaway by the Cape of Good Hope adds thousands of miles to the journey. Commercially the sea lane linking up the monsoonal lands, with their dense populations and many vegetable products, with the machine-made exports of Europe and America is very attractive because of the many return cargoes. Voyages to the Plate estuary, to Cape Town, or to Australia tap a trade that has a

seasonal flow, but on the Far Eastern run cargoes are never wanting.

The opening of the Suez waterway changed the importance of many ports by altering their relative positions to the main arteries of world commerce. Genoa and Marseilles are two ports that have benefited particularly. The Suez Canal also explains the dominance of Bombay over Calcutta as a passenger port for India. Even the ports on the east coast of the U.S.A. have benefited, for it is both shorter and cheaper to send goods to India via Suez from New York than via Panama. The Philippines are the same distance from New York by either route.

The Panama Canal differs from the Suez Canal in almost every respect, except for their basic similarity of joining two of the bigger oceans. It was completed by the government of the United States in 1914 after the private French company that had dug Suez had failed. The canal, 42 miles long, cuts across a mountain range and has three flights of locks. Unlike Suez, too, Panama was conceived as a strategic project that had secondary but influential commercial possibilities. The principal commercial effect of the canal was enormously to shorten routes from New York to the Pacific coast ports. It brought San Franciscan dried fruit, oranges, and Mediterranean products, British Columbian apples, timber, and salmon much nearer their consuming areas—the industrial cities of the north-east of the U.S.A. and Europe. Panama also revived the trade of the South American Pacific coast, increased the sales of Bolivian tin, of Chilean nitrates and iron ore, and of Peruvian cotton, by shortening the distance they had to travel to market.

In so far as trade within the British Empire is concerned, Panama is of much less importance than Suez. Liverpool, it is true, is a thousand miles nearer New Zealand via the Panama Canal than via Suez. There is, however, a very long run across the Pacific, with no coaling station or oiling port and little possibility of alternative cargo. The relative importance to the shipping of Britain and the U.S.A. is shown by the number of vessels using the two canals. Half of the 6,000 ships which make the 17-hour run through the Suez Canal annually are British; approximately the same number of ships use the Panama Canal yearly (average time of transit 7·5 hours) but only one quarter are British and almost half are American.

It must not be thought that these figures for ships passing or tonnage passing are large. The inland waterway of the Great Lakes in North America, ice-bound for four months of the year, ferries iron ore and prairie wheat from west to east. Because of the special nature of the traffic—easily handled, uniform material—and of the threat of ice, the Soo (Sault Sainte Marie) canals between Lakes Superior and Huron pass far more ships than either of the maritime canals. Despite the interruption by ice they handle about a third more tonnage than Suez and Panama combined. This, however, is the result of very special economic conditions, and from the point of view of world geography either of the sea-water ship canals is far more important.

Sea transport is especially important for long journeys and for bulky cargoes. Rail and other forms of land transport are mostly used for shorter hauls. Only in the continental interiors where no other form of transport is easily arranged do railways reach their maximum length

and importance. The relative costs of the two media are vastly different. A crate of Tasmanian apples can be unloaded at London docks after a 13,000-mile sea voyage for the same cost as a one-mile taxi journey to the dock to collect it. Consequently, coasts with good harbours and a rich hinterland have a great advantage over smooth harbourless shores. This is one geographical reason for the supremacy of Europe in sea trade. It has an indented coastline of 20,000 miles and, except in Russia, no place is more than 300 miles from the sea. Compare this with the United States, which has a coastline of only 5,200 miles, although it is not much less in surface area. The U.S.A., however, with 6 per cent. of the land surface and 6 per cent. of the population of the world, contains 40 per cent. of the world's railway mileage, and these handle 55 per cent. of the world's railway freight. The explanation is primarily geographical: the exchange of agricultural products between the interior plains and the industrial north-eastern states, the vast land-distances, and the fact that the rivers such as the Mississippi system flow contrary to the direction that the freight must travel. Social factors like the absence of political barriers as understood in Europe allowed uniformity of gauge and help to explain the immense traffic.

The U.S.S.R. both in Europe and in Asia is rapidly building up its railway network. We have already referred to the ferrying of coal, coke, and iron ore between Magnitogorsk and the Kuzbas coal basin. New construction is providing feeders to the original single-track Trans-Siberian line, linking it up with the grain and cotton of Turkestan and with the timber and gold of the north. This Siberian area is especially suited to

railway operation, for the rivers flow northwards into the remote Arctic Ocean and are frozen for five months of the year, and because, as far east as Irkutsk, the open plains and easy gradients facilitate construction and maintenance.

Political factors do not in themselves determine that railways will be laid for ease of working, nor do economics always dictate their direction. Rivalry and political jealousy may cause the adoption of different gauges, as in South America or Australia. In both these areas of pioneer settlement railways preceded the people, and it was a function of the railway to attract the population, a reversal of the conditions of construction in Great Britain and in Europe. Some railways have been built for prestige purposes and are not subject to the dictates of either economics or geography. Thus the trans-Andine railway joining Argentina and Chile with its two hundred breaks of gauge, its rack sections, and its corkscrew tunnels has been an engineering triumph but a financial failure. The many transhipments necessary make it unprofitable for freight.

To-day the mesh of communications includes both motor roads and airways. Roads, necessary for the movement of wheeled vehicles, have been a medium of communication for centuries. The administration of the Roman empire depended on the maintenance of the road system. Even more vital to the life of an empire were the roads of the Incas of South America, crossing rugged mountain sides, bridging chasms, and imposing a uniform rule on scattered peoples through 35 degrees of latitude. In this century the internal combustion engine has revived the importance of the road but for long-distance haulage of heavy freight on land the railway is still supreme.

Air transport also depends on the internal combustion

engine or some of its more recent developments such as the jet turbine or the simple jet. The atmosphere differs from both land and sea in its universality; it is not broken up by large masses of any other material as the sea is broken up by the continents. High mountains now offer no obstacle to travel, wide ocean spaces can be partly ignored. In the first chapter we saw how the aeroplane is giving us a new appreciation of the sphericity of the earth. It *may* make the North Pole a route centre for the great-circle tracks joining east and west Asia cross the Arctic Ocean. However, we must remember that technical considerations are not the deciders of the final routes. Air tracks to-day follow the girdle of dense populations that runs from New England through Europe to India and Japan, parallel to a great extent to the offshore sea-lane that skirts the world via Suez. The southern continents are still cul-de-sacs, feeder ways to the principal channel of movement. It would no doubt be possible to link South America with South Africa and Australia in a great circum-Antarctica air route, but in these lands most people want to move backwards and forwards to the industrial centres rather than to one another. Traffic by air is still largely passenger traffic, the freight that can pay the highest mileage charges, so air routes are dominated by concentrations of populations and the aeroplane follows the passengers rather than taking the shortest (great circle) way between two destinations. One of the most vital contributions of the air to modern life has been in the sphere of short-distance travel in northern Europe. The terrain, broken up into islands or peninsulas by the sea and by long open estuaries, has meant that journeys from place to place often involved the annoying alternation of change

from rail to boat and back again. Further, these change-overs had also the habit of occurring between midnight and dawn when the human spirit is at its lowest ebb. The aeroplane has solved that problem, so that Britain and Ireland lose some of the disadvantages of being islands.

We may now turn back to our original question: Can geography explain the reasons for the concentrations of machine industry in north-west Europe and north-east America? This whole chapter has been a partial answer. Summed up we may say that geography had a lot to do with the rise of these civilizations. The indented coast-line of Europe, the presence of coal and iron, the ability to sail on the ocean, the conquest of the forest soils with the deep plough, the social ingenuity to evolve appropriate methods of human grouping like the joint-stock company, perhaps, too, the energy and drive of the people, is due to the stimulus of the cool, changeable, cloudy climate. Climate, topography, natural resources, soils, these are geographic conditions that affect life. Position in relation to other lands and peoples is another geographical factor of great importance. Travel by sea and contacts with many different cultures within Europe and beyond Europe were a further source of stimulus. All these in combination with social forces, the product of the meeting of people, are necessary in attempting to answer any question about the origins of a civilization.

Here we have been discussing mainly the economic aspects of geography in the modern world. The effects of the landscape on the political life of the peoples is less obvious but of equal importance. The geographer has an important contribution to make to the study of the political life of the world and we shall have to consider this in the next chapter.

CHAPTER VI

GEOGRAPHY AND POLITICS

GEOGRAPHERS mark on the map of the world a number of regional divisions which masquerade under many names—natural regions, climatic provinces, cultural areas, and so on. While there are occasional minor disputes over boundaries they have all an underlying unity and it is the claim of our science that these areas form the fundamental divisions of the surface of the earth and that they can only be ignored with difficulty. It is true that each scheme of division has a different set of boundary lines, but somewhere along the fundamental divisions, at present hinted at in these attempts, lie the frontiers of the future. Geography is a basic factor in life, it is the study of the ground plan. But while geographic facts are relatively unchangeable, their application to human society is apt to change from time to time. Thus distance ceases to be a barrier with improvements in communications, and tunnels may be said to remove the existence of mountain ranges so far as the human traveller is concerned.

The geographic factor is so often seemingly ignored in politics that we may well be sceptical of its effects, but a brief study of the modern world will demonstrate its applicability. The first thing to do is to get a classification of the geographical bases of states.

Looking at the variety of colours and shapes on a political map of the world the base of politics would seem to be chance rather than the operation of any

fundamental principle. We are all aware of the rapidity with which frontiers have been changed during our lifetime and we must recognize that the frontiers of to-day will certainly not be those of to-morrow. None the less, it is possible to make a classification of states on the basis of the type of area they occupy, that is in terms of geography.

First, there are a few states that have no sea coast at all; four in Europe, two in Asia, two in South America, and one in Africa. They are all of little importance in the political geography of the world for their problems are entirely confined to their contacts with close neighbours across a land frontier. There are, too, a few states that are islands; the outstanding example of this is of course Great Britain. However, the geographer also wants to know the type of island. Small oceanic islands, like those in the Caribbean Sea that are politically independent, differ markedly from island groups like the British Isles or Japan. These latter are known as continental islands for they consist essentially of parts of the continent isolated by a geological accident. In the case of Great Britain this separation helped towards the early appearance of a single political power, for the sea frontier meant security from external troubles. The power of the political unit which emerged lay in its large population in relation to the area, a population as much a product of the fertile lowlands of the south-east of the island as its own foodstuffs. In a society that changed its methods of agriculture very slowly this population could not increase too much, for, as in all islands, the amount of good land available was fixed. The development of a single political power in England took place during the Dark Ages at a time when such slow change was normal. If

however, we are to understand the later repercussions of that power on the mainland of Europe we must go back to the map and at the same time take a longer view of history. The atlas map shows the peninsula of Kent balanced at a crucial human divide in Europe. The east coast of Britain faces the part of Europe east of the Rhine, the Germanic world. The south coast faces France, a part of Europe with a considerable heritage from the Romans. In prehistoric and early historic times this island received recurrent waves of invaders now from the south, now from the east; the beaker folk and the Angles and Saxons are examples of peoples who came from the Rhineland and the German coastlands; neolithic farmers, the Romans, the Normans, and many other peoples came from the south. Both streams of 'immigrants', one ultimately derived from the Mediterranean lands, and the other in contact through eastern Europe with the horsemen of the steppes, contributed to the development of the institutions of Britain.

Even under the primitive and slowly evolving system of medieval agriculture it is obvious that, given political unity, the continental shores opposite this island could support a much larger population than Great Britain. If invasion was to be forestalled, political effort must be expended on the navy so that troops could not be landed on our shores, and also on the prevention of that political unity that would give irresistible military force to a continental power. The political manœuvring, the naval wars, of the subsequent centuries stem from the geographical position of this island. The maintenance of supremacy at sea involved us in a long series of contests with both the French and the Dutch as those countries attained full national maturity. To a geographer the two

wars of this twentieth century were continuations of the long struggle to prevent a single power becoming dominant in Europe and especially to deny free political access to the Rhine delta to the major nation states on the Continent. While in outline this seems bare and almost self-explanatory, the details are complicated and fascinating, but we must return at this point to our classification the geographical characteristics of the territories of the nation states in the world to-day.

Few modern states are either wholly surrounded by the sea or wholly cut off from it. The vast majority of countries have both land and sea frontiers. In studying the politics of these states their position with relation to other land-masses is most important. For full development economically and politically in a seaboard state there must be another shore within reach of the skill of its sailors, otherwise the sea becomes a barrier and the country has to turn its back on the ocean. Native peoples of Africa, South America, and North America were so frustrated by the sea. Provided there is a seaboard that gives shelter to shipping and another land with which to trade or fight (aspects of contact between peoples differing largely in degree) there will grow up a seafaring nation. This is particularly noticeable where the hinterland is rugged. Thus the early Phoenicians, living on a rocky shore, exchanged their cedar wood and the purple dyes obtained from shellfish for grain and manufactured goods from Egypt. So, too, the Greeks took to the sea, and the Norse and the southern Chinese; all exported men from an inhospitable terrain that could not support without trade the natural increase of healthy mountaineers.

Just as not all sea coasts are alike, so too the seas differ

amongst themselves. The opportunities presented by contact with a landlocked sea such as the Black Sea, the Baltic, or the Mediterranean, depend largely in these days on ability to get out and reach the main ocean. Access to two seas means added opportunity; it also means added difficulties in defence. If the two seas are in fact oceans, only the largest of modern political units can support the men and the navies necessary to dominate the two at the same time. France and Spain are two European countries that have coastlines on two major seas and it has been a source of weakness to both of them. Large population and great productive resources are needed in such circumstances and on the oceans to-day only Great Britain, aided by the Empire, and the U.S.A. are significant. The competitor which has sufficient size and resources, that is the U.S.S.R., has such poor contacts with open water that it is not yet important as a sea power. Its thinking and outlook are dominated by the land-mass it controls. Russia thinks in terms of land movements, that is in terms of steady advance outwards from a centre instead of viewing the world as a seaman does, in terms of routes and selected control points along them.

We could select for description peninsular states like Denmark, or isthmus states like Panama, Mexico, or indeed Egypt, but these types of geographical relations add only details to the outline presented above. Some internal geographic factors which influence the politics of states deserve to be mentioned. Of these, space and shape are most important for our purposes.

Size is a vital factor in politics, but the area must be under effective control, so that mere size without adequate communications is of little political significance.

The greatest area that could be controlled easily in the days before the railway is somewhere about that of France. Railways enormously increased the possible range of a central power and the quick methods of speech communication, telephone and telegram, which came into use about the same time, still further increased the possible size. States which were reaching political maturity at the outset of the railway age tend to be large; examples are the U.S.A., Canada, and Australia. Judged by the standards of communication in existence to-day the political development of the world is woefully out of alinement.

We must distinguish carefully between size and shape. The ideal shape is one where all sections of the periphery of the state, the frontier, are reached with equal ease from the centre. In theory a circle would approach closest to this but, of course, no state is of this shape and, anyway, the landscape always allows of easier movement in some directions than others. Irrespective of size, the most disadvantageous shape is long and narrow. Such countries find it difficult to prevent the extremities from being absorbed into the framework of their neighbours. Regionalism, leading to separatist movements, can develop in parts away from the central focus in any country, but is most marked in these instances. As geographers we must be practical and keep actual examples in mind; description and interpretation of the actual world, rather than theoretical discussion, is the strong point of our science. We notice how within Great Britain the most distinctive regional feelings developed in the westward and northward peninsulas, away from the plains of the south and east. There are good geographical reasons for the regional consciousness of Wales,

Scotland, and Cornwall; they are survival areas, where overland movement and conquest have been difficult. In a sea empire, such as Britain built up, once the main island had been unified in a political sense, the peripheries are at the ends of the sea routes and in the colonies and dominions this awakening of regional autonomy is important. In one sense the American colonies were lost because the eighteenth-century sea journey was too long and weak contacts with the motherland allowed the development of political ideas.

At home the isolation of the Irish Sea prevented early conquest of Ireland. The Angles and Saxons did not sweep far enough west to approach it and at a later stage the difficulties of untamed bog and scrub made military conquest slow and not too secure. It is significant that Ulster, the province furthest removed from the political nerve centre in London, was the last to be conquered, submitting only some 400 years after the establishment of English rule in the Dublin area. Ireland has been saved many continental invaders by Great Britain acting as a buffer. The Romans never established themselves in Ireland; the ideas of the reformation, moving by paths which followed an old-established geographic route down the Rhine from Switzerland to the Netherlands and so to lowland England, did not penetrate the highland barrier and across the Irish Sea. This religious force did reach Ulster after a considerable time-lag, but here again it followed a well defined route from the Frisian coasts to the Forth valley in Scotland and then across the narrow North Channel, where on any fine day the black and white cliffs of Antrim beckon clearly. The road was known earlier, for the prehistoric beaker folk, nurtured like Calvin in the upper Rhineland, have left

sufficient evidence to show that they used it in the second millennium B.C. All these influences meant that the people of Ireland had a different outlook on the world from those of England and these divergencies, in great part attributable to geographic factors, became more marked as England, became industrial. They help to explain the regional feelings that led eventually to the separation of Eire from the political control of Great Britain.

A most important geographical aspect of politics arises from the tendency of states to expand, a tendency that seems to be universal. Here we must beware of taking a view too short in time, for the nation state is a continuing organism and even those states which now seem perfectly satisfied with their present-day frontiers have had expansionist ambitions in the past and may have them again. For example, Holland has held extended territories overseas at one time and Denmark has controlled Scandinavia in the past. When opportunities arise, as in peace settlements after European wars, nearly all states seek more territory, none offers voluntarily to vacate areas they once controlled. Such expansion is governed by many considerations and the underlying geography, the basic factor in movement, often determines the direction of the territory sought, although geography is usually blatantly ignored in fixing the limits demanded.

Admitting, then, that there is a tendency to grow, the method of growth is that favoured by the home terrain. France, originally a small area in the Paris basin at the junction of many of the tributaries of the Seine, extended its territory outwards along the river valleys until it had overcome the dukedoms of the middle Loire. There was

in the Middle Ages a period of oscillation between Paris and Orleans, but the site of Paris gave the greater nodality and eventually the ruler of the Ile de France prevailed. From this territorial base political control was further extended again by river routes, to the Pyrenees and the Mediterranean. In the New World the French made more skilful use of the rivers for the reconnaisance of the country and for the annexation of territory than the British or any other power. It was their pioneers that first found the Great Lakes and were first to float downstream on the Mississippi to the Gulf of Mexico.

A parallel case in Europe is the extension of the sway of the rulers of Muskovy, a small principality at a crucial river junction in eastern Europe. They travelled through the forests of Russia by river boat (the name Russian means oarsman). The Volga led them southwards and eastwards to the Caspian, other rivers reached by easy 'portages' took them to the Arctic, to the Black Sea, and to the Baltic. The push east across Siberia in the seventeenth century was made possible only by hiring Cossack horsemen.

In early times rivers offered ready-made roads which did not wear out however much they were used. Many states developed in river valleys. One has only to think of Egypt, Iraq, or China. The Polish state as re-established after 1920 was virtually the drainage basin of the Vistula.

Not all great rivers have seen the establishment of a single authority along their course. In Europe the chief exceptions are the Rhine and the Danube, where each section of the river has been under a different régime for centuries. The Rhine from its source to the end of its

mountain sector at Basle belongs to Switzerland. The Swiss federation of cantons, each of which has a certain geographical unity, represents an exception in the political evolution of a mountainous region, a triumph of man over the difficulties inherent in the topography. Mountain country, where fertile plains on which populations can be built up are tiny and isolated from one another, more usually leads to a multiplicity of small states each jealous of its own individuality. The Balkans are a case in point. Amongst the many states there, Yugoslavia struggles for unity against the difficulties both of shape and terrain. It is in the mountains, too, that we find the dwarf states, organized around foot transport and surviving into an age of machines, such as Andorra in the Pyrenees, Monaco and Liechtenstein in the Alps, and Albania in the Balkans. In the long run the destiny of mountainous tracts, especially those that are fragmented in topography, is to be conquered by powers based on the wider potentialities of the lowlands or to be unified by ideas taken over from those areas.

Returning to the Rhine, the middle course from Basle to Bingen is a rift valley, a geographical unit, yet historically it has rarely been united. The river way has always been a corridor of movement for peoples, from the prehistoric men who made the beakers referred to earlier, to the modern bargees. The easy ways into and out of the rift valley, to the Saône and the Rhône by the gate of Mulhouse as well as east into Bavaria and west into Alsace, have helped in the dispersal of peoples. The flat valley floor, dominated by hills on either side, has meant that the river served as a frontier dividing the kingdoms based on defensive positions beside the corridor. The

middle kingdom founded by Charles Martel had a short life. Here again a close study of the geography helps to throw some light on the political evolution of the region.

Lastly, omitting the gorge section, on the European plain the lower Rhine must be viewed not only in relation to the lands to the east and west but also in the light of the position of Great Britain to the north-west which has probably been the deciding factor. Westward lies France where, once over the watershed, all roads lead to Paris. Eastward begins the great European plain which stretches with no mountain barrier to the Urals. There are, however, several distinct hindrances to the movement of peoples, even if we neglect the fact that the mixed oak forests of medieval days were not likely to encourage easy travel. On the plain, rivers tend to flow from south to north and there has been a tendency for each valley to develop a unity of its own. This was perhaps best obtained in the Vistula basin, isolated from east and west by marshland, in the west the Warta and Obra marshlands which even to-day divide the railway eastward from Frankfurt-am-Oder into two branches, and in the east the even greater expanse of the Pripet marshes. West of the Oder the relatively open plain coupled with the parallel river courses and the terrain of the Bavarian plateau, broken into a mass of small geographical units, many of them single states, has been the underlying factor in the late achievement of political unity by Germany. There has always been a struggle to unite the differing regional consciousness of east and west, north and south. It took the railway to *unite* the territory under a single government. Once united its diversity of resources, not only in soil but also in mineral wealth, gave it in turn great potential political strength.

The lower Rhine, the delta, lies between the political hearts of Germany and France. If either of those powers controlled that vital area they could dominate all Europe north of the Alps. Offshore lay the unified domain of Great Britain, and if any continental power should incorporate the Rhine delta within its frontiers she would be exposed to attack. In the light of this triangle of forces the political neutralization of the lower Rhine is obvious. No one of the three powers, France, Britain, or Germany, could allow any of the others to have absolute control; to do so would be to commit political suicide, and thus the states of the delta, Belgium and Holland, remain independent.

Taking the longer view, however, sea-coast states are usually absorbed into the territory of the continental power, and offshore islands, however powerful, fall under the sway of larger continental powers. Expansion, as we have said, is a perennial tendency of states, and the great goal of expansion is to reach the sea. The weakness of small independent political units based on the sea-coast is well illustrated by the east Baltic states. Estonia, Latvia, and Lithuania, occupying the lower courses of rivers of the European plain, were partially protected by moraines and marshes on their land frontier. But their position was one of insecurity for they were dominated by a large power to the east and have now been absorbed within its frontiers.

The sea by which the trade and the ports of most of the countries of the world may be reached has been the great goal of Russian expansion. Few great states have had so short a frontier on the unfrozen ocean. For long Murmansk, isolated across the northern pine forests and swamp-lands, was its only ice-free port in Europe. The

U.S.S.R. in its earlier years was in effect the greatest landlocked state in history. Most countries that lack a seaboard are mountain states, occupying a buffer position like Switzerland or Tibet or Bolivia. The Soviet Union is essentially the great plains of Europe and Siberia, the *heartland* of Eurasia, flanked at every outlet by well established and populous lands, China, Turkey, and the European nations. Elsewhere natural barriers, such as the ring of high mountains and plateaux to the south or the frozen Arctic to the north, intervened. The practical way out lay through the Black Sea. Unfortunately the geography of the outlet, a narrow channel, assured that the land power in control of Asia Minor also controlled the straits. These Dardanelles–Bosphorus narrows have been throughout history the scene of repeated struggles between land-based armies and sea powers. The lesson of history is that sea power has held control of this vital waterway only for brief periods and under special circumstances. The Greeks who besieged and captured Troy, the sixth city on the site, began one of these short episodes of sea supremacy. The importance of the straits in early times lay in the widespread exchange of products between two contrasting geographical regions that took place through them; grain, wool, and honey from the Black Sea against olive oil, wine, and fruit from the Mediterranean. In medieval times the Turks, a land power, controlled both sides of the passage. There have been at least seven wars between Turkey and Russia concerned with the question of who shall be master of the Bosphorus. The sea power of Britain has come to the aid of Turkey in this checkmating of Russian expansion.

Failing to reach ice-free water in the Mediterranean,

Russia also failed at other possible outlets. The British navy was powerful in the Persian Gulf, and at the Pacific end of the long trans-Siberian route Japan and British naval power were strongly represented. Vladivostock, founded in 1860, is frozen for 110 days every year and must be kept open by ice-breakers. Japanese expansion, in the period before 1945, stopped the attainment of ports further south in the Pacific. Anyway an ice-free port on the Pacific is not of much use for the relief of traffic that originates in European Russia.

The modern world has been built up around control of the seas. This method of approach can best be seen in colonial territories which often extend inland from the original settlement at the mouth of a river. Contrast the shapes of the British colonies in West Africa, isolated from each other, with the continuous band of French territory in the interior which is a result of trans-Saharan movements and which extends downstream to the coastline to fill up the interstices between the British colonies. France with her most vulnerable frontier across the land-divide in the east and with her sea coast divided between the Atlantic and the Mediterranean has always had to concentrate her main strength in the army. Britain, an island state, has depended in all her crises on the navy, and the distribution of the British Empire shows this strong emphasis on sea transport. Large compact blocks of territory like Canada or Australia were first settled on the opposite coastlines and, after that, union depended on the railway. Even to-day the greater part of the population in Australia lives around the coast and it is worth noting that the great cities of the southern hemisphere are with one exception (Johannesburg) all sea ports.

If we attempt to take a world-view for a moment we must return to the fundamental distribution of land and water. World history is made by peoples who live between 25 and 60 degrees of latitude in the northern hemisphere. The major land-masses lie there, grouped (as we saw in Chapter II) around the frigid Arctic Ocean. We have already referred to the fact that the major concentrations of populations lie in a broad zone stretching from north-east America to Europe and then passing by way of the Mediterranean Sea to the monsoonal centres of India and China. The land area stretches in a compact block from Transamuria to France. Offshore to this great world-island lie the seats of the three sea powers, Britain, the U.S.A., and Japan, the latter for the moment in eclipse. Jutting away from this world-centre are the oceanic islands and peninsulas of South America, Africa, the East Indies, and Australia. They are in all probabilty destined to remain subject to the major power in the northern hemisphere. The tendency in politics in the past century has been towards the establishment of bigger and bigger units and there is no doubt that, with rapid communications and the methods of influencing large numbers of people at once, the technical framework for setting up a single political state for the whole world has been achieved. If ever one power should control the world-island these southern lands, isolated one from another, could not hope to remain independent. No one power has yet attained this political predominance; the closest approximation has probably been the short-lived empire of the thirteenth-century mongols under Genghis Khan who ruled from China to Russia. Such a power has not yet had time to appear as our conquest of land movement

is so recent. The horse was the swiftest means of progression known until the machines of the nineteenth century. Movements by sea can only with difficulty penetrate to the heart of Asia and conquest by a sea power of an area so remote from the ocean has been practically impossible, so that Siberian Russia has been aptly called the *heartland.*

Historically, too, a continental power with its richer

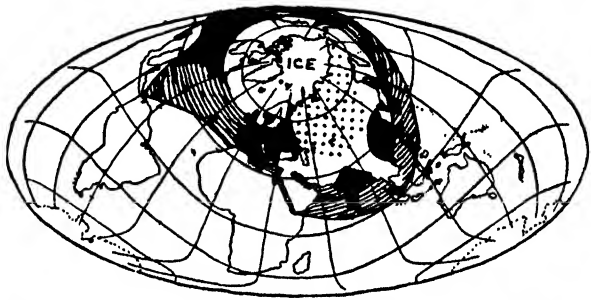

Fig. 12. POLITICAL GEOGRAPHY AND THE WORLD MAP.

The Heartland is dotted, major areas of dense populations are solid black, and the great zone of movement of men, goods, and ideas is lined.

after Fairgrieve and Fawcett

and more varied topographic base has ultimately been able to control such politically precocious island-states as lay offshore. Access to the sea, a greater population, a greater security because of the larger land-area have all led to this. Once Italy was unified, Sicily became a satellite of the mainland; Crete lost its independence and power once the Greek mainland became politically conscious in classical times. Unless we assume that the present position is static, a most unwarranted assumption, then we must admit the possibility of the eventual conquest of this island by a continental power, or at any

rate the closer identification of British politics with continental affairs. To-day and for the past few centuries the sea powers have been in the ascendant, a reflection of the unequal rate of human mastery of the techniques of movement. Once a large and well integrated land-power reaches the ocean it can, if it chooses, build up a navy of its own.

We may then consider the *heartland*, a pivot area on the edges of which the human drama has been enacted, as in its present stage of development the most probable centre for a potential world-state. It is the only extensive and rich part of the major land-mass that is sufficiently remote from the sea to be immune from naval conquest. Its harsh climate, its poor soils under the immense coniferous forests have hindered it and prevented the growth of any large populations in days when the people had to be fed on the produce of the locality; if there develops a modern industrial community, we may have to alter our strategical thinking to something like the outline given here. The foresight to make such an analysis belonged to one of the pioneers of modern geography, H. J. Mackinder, who as early as 1904 distinguished the *heartland* as a potential seat of a world-power; we have restated in brief the main thesis presented in full in *Democratic Ideals and Reality*, a book first published in 1919. The new factor of air power is more likely to favour this thesis than to reinforce sea power. For in air warfare a central position is a major advantage, provided there is sufficient military and industrial strength to defend the citadel. The air at last reduces the effectiveness of the barriers of ice and mountain surrounding the pivot area and permits easy movement into and out of the *heartland*.

The interaction of geography and politics is even more complicated and involved than the relationships studied by economic geography. History, stages of development, and the aptitudes which human groups have developed over long periods, all combine with the fundamental geographical influences to make a complex whole. In the study of the states of the world geographic factors are long-term influences. Human wills and human desires may override them for a period; geography does not argue, it just is. In particular the temptation to analyse geographic factors for the purpose of seeing future tendencies is very, very hazardous. Prophecy calls for a knowledge of all the factors and of their reliability in the particular situation, and it needs in addition a special flair that sciences do not normally give. Geography is important in any understanding of human society. It can give a detailed account of a small area or a revealing survey of the whole surface of the globe. The geographical factors important in a study of politics are size, shape, and location, in addition to climate, topography, and resources, material and human, which underly the economic and social life of the countries under review.

CHAPTER VII

GEOGRAPHY IN THE FIELD

THE previous chapters have taken the whole world as their area of study, and this is the true extent of the field of geography. They have ranged widely and dealt with the major facts of the physical, economic, social, and political aspects of the subject. Geographers, however, are very conscious of the particular problems of small areas and the greater part of the space in geographical periodical literature is devoted to intensive studies of areas that are tiny when judged by the amount of surface they cover.

Individual physical units, like a river valley, a coastal strip, or a plateau, constitute the geographic equivalent of the laboratory in the physical sciences. A single individual or a small team of workers can observe, analyse, and describe such a region from direct field-study. The notes and impressions brought back give new life to the statistics which may be used in the final report and help considerably in the preparation of specialized sketch-maps. Text-book descriptions of countries and of the life of man in them depend for their value on the first-hand accounts of field workers such as these.

In one sense this book has been a geographical introduction to geography: it is typical neither of the text-book nor of the monograph and deliberately so. On the other hand, although the kernel of the subject may be the detailed description of minor regions, the realization that such detailed reports must be fitted into a wider

whole and that some of the minutiae must be sacrificed to this end is the hall-mark of a good geographer. He must attune himself to visualize from a study of his home region, by comparison and contrast, all the varied environments of the world. No geographer can afford to neglect the study of the countryside on his doorstep to dream of distant places and exotic names.

The student of geography will understand the Ganges plain all the better if he has already explored a river valley in his own country. Two hundred miles of river alluvium without a stone larger than a pea can be comprehended best in the light of the few square miles of silt and mud at the mouth of our greatest rivers. The requirements for these geographical field-expeditions are simple enough: a preliminary study of the maps of the area and an eye that *sees* when in the locality itself.

What might we hope to see in any specific area? Rather than list a series of headings that could well be endless and would be of little value, we give below in outline the beginning of a regional study of a small area. The region is the valley of the river Braid, County Antrim, Northern Ireland.

County Antrim is in the north-east of Ireland and if we are to understand this valley the first thing to do is to relate it to the relief of the county. Antrim, if we except small areas in the north and south, is essentially a slab of basalt some hundreds of feet thick. This is gently tilted up at its edges and depressed in the centre, like some of those old-fashioned tombstones that have been supported only at the corners. The central hollow is occupied by Lough Neagh and the valley of the river Bann. A ridge parallel to the Bann divides its valley from that of the river Main which flows in the opposite

direction, but the analogy of the slab is substantially correct. The uptilted eastern edge of the basalt faces the east coast and the North Channel as a line of cliffs and bays. The scenery here, black basalt towering over the underlying chalk with many landslips giving a stepped outline to the coastal profile, is magnificent. Rivers have tumbled over the edge and cut deep valleys and made embayments in the coast. Down the gentler slope to the central depression course other streams, and the Braid is one of these.

The ice of the glacial period swept over this country from the north-east, from Scotland. It deepened the coastal valleys and at one period ponded up water in them. Overspills from the temporary ice-dammed lakes coursed as great rivers down the present west-flowing valleys and helped considerably in the final modelling of the Braid valley. The ice itself left boulder-studded clays and sands in County Antrim and the Braid district is one of the areas of sandy deposits. There is a great contrast between this valley and that to the south, the Glenwhirry. The latter is narrower, clay floored, infertile, and much less densely peopled. Even the Braid would not be noted locally for its fertility if the farmers had not been hard working and energetic. Still, it must be admitted that the glacial epoch left soils that encouraged their efforts by a favourable response, for presumably as much work had been put into the Glenwhirry soils as into those of the Braid before the different nature of the terrain was appreciated.

While the landscape shows many signs of ice erosion and deposition in the hummocky mounds of sand and clay, in the notches cut by glacial rivers along the skyline, signs are not wanting of pre-glacial times. Closer

observation of the physical map, fig. 13, will show wide stretches of level land above the present valley floor. A walk up any of the tributary streams will reveal a series of rapids alternating with lengths of quiet water. On the level shelves on the hillsides these tributary valleys are

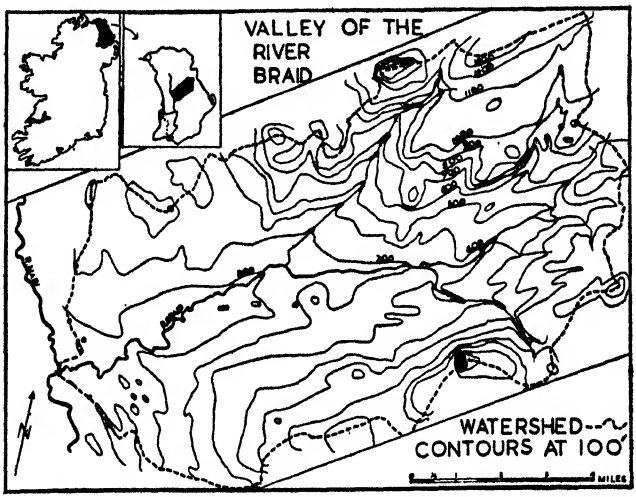

Fig. 13. BRAID VALLEY, PHYSICAL.

wide and slopes are gentle, signs of mature erosion. Between these areas and the main valley occur short steep-sided sections on the tributary streams where the water tumbles down. These physical facts must be explained by reference to the cycle of river erosion. The flat sections with mature valley-forms represent former peneplains graded to a sea level high above the present one. Steep breaks of slope may represent former sea-cliffs. In the Braid such fossil landscapes are best preserved above 1,000 feet and as a shelf on either side of

the present valley from 600 to 800 feet above modern sea level. The former peneplain sloping gently up to the crests of the hills is particularly noticeable on the north side of the valley; the headwaters of the present stream originate in part on the peat-covered 800-foot peneplain at the eastern end of the map, and a long tongue of this peneplain juts westward from the cliff-fringed hill of Slemish to form the southern watershed.

One can say little of the special features of the climate of small areas such as this valley. The study of micro-climatology has not yet been attempted for many places in the British Isles and the data does not exist. Every farmer knows the qualities of his fields and soils; that this field will ripen crops earlier than that; that late frosts affect one place rather than another. This knowledge belongs to the pre-scientific age; it is not capable of measurement nor of being applied uniformly over a considerable range of landscape types. It has its value, but the conclusions depend on many personal factors of observation, of coincidences which may or may not indicate cause and effect. Anyone who tries to buy a field or a farm will hear nothing of the frost pockets! This Braid valley, situated in latitude 54° 50′ N., can only be described by us in terms of the climate of Ulster. The local factor that we can observe is that the northern slope, the one facing the sun, is more favoured than the southern side of the valley, for cultivation climbs higher there by 100 feet or more. The cool, cloudy, rainy weather all the year round with a minor rainfall maximum tending to occur in August, means that the only cereal that will ripen satisfactorily is oats. Wheat can be grown only with difficulty, and maize, that great feeder of livestock, refuses to ripen. The 220

days in the year when growth is possible severely limit the agricultural possibilities. Lacking coal or hydro-electric power resources, lacking most mineral ores except a few small and uneconomic outcrops of bauxite, agriculture is the only possible way of life. Like nearly all north-western Europe, agriculture here concentrates on livestock fed on the rich summer growth of pastures and on hay during the four to five months of stall-feeding. The abundant rains, 40 inches in an average year, the cloudy skies, and the equable seasons, encourage the production of livestock and livestock products, for we have not yet begun to use the nutritious grass stems, the most easily raised crop, directly as human food. The agriculture of Northern Ireland as a whole—and agriculture is the most important industry—concentrates on livestock. Only in the past fifty years has much progress been made in organizing farming for the market provided by industrial Britain and, as with all such programmes, results have been achieved slowly and cumulatively so that the past decade has witnessed a great expansion of the output. Milk, fat and store cattle, eggs, table poultry, and pig products are all characteristic. Typical too of the pre-1939 period in all this hay and dairying belt of western Europe was the increased stock-carrying capacity of the land. Much of the increase was due to the import of maize and other feeding stuffs from abroad, but some of it—of more lasting value—depended on scientific methods of grassland management.

We can find out from the official statistics that the Braid, like the rest of Ulster, is a region of small-holdings; that the farms are worked by the owner and his family with only one family in fifteen employing any paid wage

labour all the year round. What we can only discover by going and looking closely at the valley is the impact of this on the landscape. It means a country of tiny fields, averaging two acres or thereabouts, and a variety of crops growing in them, giving a patchwork of different

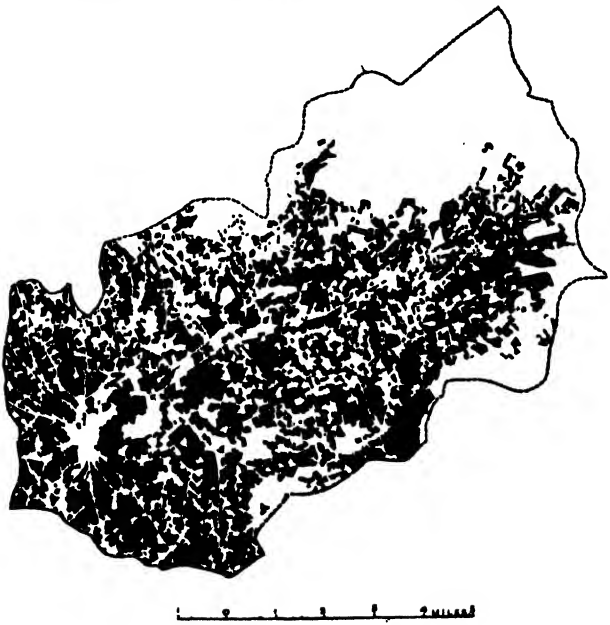

Fig. 14. BRAID VALLEY, GRASSLAND.

greens or yellows according to the season of the year. The dominant colour is green, as the greater part of the improved land is under rotation grass. The land-use maps bring out this aspect more clearly than pages of description. Each farm, whether of ten acres or of

fifty, must have several fields; five seems to be the absolute minimum, one for grass, one for roots and potatoes, one for corn (oats), and one for a cash crop; in the Braid valley this is nearly always flax or seed potatoes. In practice, with a long rotation five fields

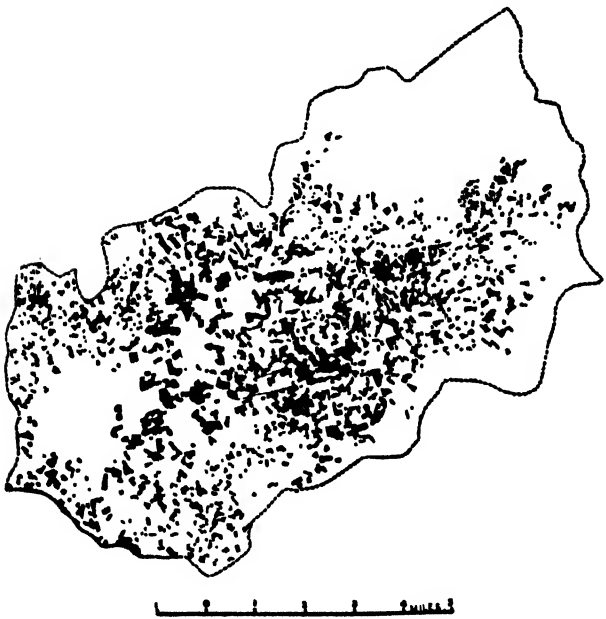

Fig. 15. BRAID VALLEY, ARABLE LAND.

are insufficient, two or three fields in grass or hay are needed. These farmers cultivate carefully and intensively, they manure heavily, and are once again using lime in quantity to counteract the effect of the recurrent showers in leaching the topsoil. Each field

is divided from the next by well-kept fences, not of barbed wire or of wood but walls of earth or stone. The stone walls, built up carefully of rounded boulders from the ploughland, are especially typical of the upper fields towards the limit of cultivation.

Standing on Slemish mountain, a hill 1,437 feet high with scarped sides which fall 400 feet to the 1,000 feet peneplain and which may be former sea-cliffs, we can look at the valley spread out below as on a map. Isolated farmsteads, each with its cluster of outbuildings for the animals, dot the valley floor. Westwards towards the Main river they stand out clearly, whitewashed and clean. Towards the east we see no houses at all; in this direction each individual house hides behind its shelter-belt of trees, protected from the prevailing west winds, and only the curling turf smoke discloses its presence. A few tiny patches of hazel or thorn scrub mark infertile rocky bosses amongst the cultivated land. Apart from straggling ash or sycamore trees in the hedgerows, the only timber in sight is on a hill on the opposite side of the valley. This marks the home-farm of a former landlord, now a farmer like the rest of the peasant proprietors although he still operates on a larger scale and uses hired workers.

The wide scatter of the farmsteads, and the small enclosed fields, are the dominant pattern of the landscape. When we descend from Slemish and begin to walk along the upper limit of the fields skirting the wild moorland, the whins, the boggy depressions, one or two discordant elements appear. We note wide stretches of rough hill-grazings and by judicious questioning of the farmers discover that the cattle on them belong to different owners. The Scots accent, the strong sense

of individual effort, and the individual ownership of the parcels of farm land all fit with the single house pattern and not with communal grazing lands. As we proceed we notice that along this upper margin of cultivation in some places little clusters of cottages are present. Some

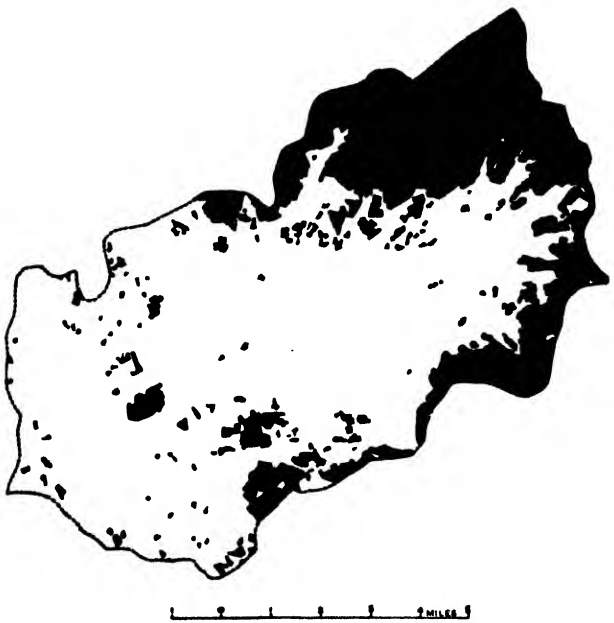

Fig. 16. BRAID VALLEY, HEATH AND MOORLAND.

are obviously tumbledown, others are well cared for and have four or five inhabited houses. Here is an exception to the general rule of individual farms that ought to be inquired into.

The first impression is that this is obviously a link with

the past, a social fossil, and its investigation will require a search in the history books or, as no one has yet written a full economic history of Ulster, in original documents. It will also mean prolonged inquiry from the people on the spot and, to check their statements,

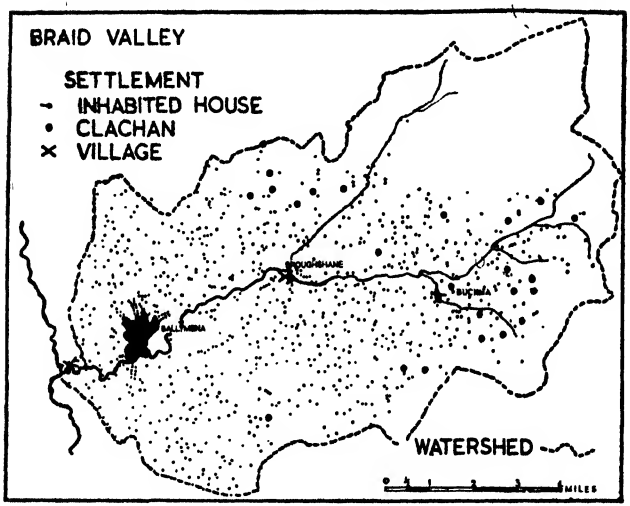

Fig. 17. BRAID VALLEY, SETTLEMENT.

observations in the field. Full details are not yet known, but our inquiries in the valley show that the house clusters are a well-known feature of the area. Associated with them in the past was a whole method of agriculture and of social relationships which may go back to prehistoric times and which was different in many ways from that of the early English village and its three-field agricultural organization. Here we may only pause to describe what may be noted in the valley: a field or two

at Racavan owned jointly by three farmers whose portions are divided from one another by grass balks rather than hedges; the fields of the *townland*, the basic social unit in Ireland, which belong to individual owners scattered here and there over the surface; the farmed area seamed by a network of paths and rights of way. In the house cluster, which Professor Estyn Evans of Belfast calls the *clachan* after the Scottish custom, we find such a haphazard layout of buildings and outbuildings that the fact of one man's byre being situated immediately behind a neighbour's farm kitchen and approachable only by a narrow tortuous path, need not surprise us. Everyone is related to everyone else; as one man said, 'In —— we're all friends through other and the devil's our uncle'. The common grazings on the hillsides, the rights of turf cutting on the mountain peat bogs, the extensive black area of fig. 16, permit a more intensive use of the arable lands. Cattle can be pastured there during the summer, thus allowing a higher proportion of the land to be in crop. This cattle pasture, where without fences the beasts have to be herded, is a form of transhumance, less intensive and to-day less vital to survival but essentially the same as that practised by the Swiss farmer on the alp or by the peoples of the Balkans. Clachans are well known in the west of Ireland, where the fragmentation of the fields amongst different owners reaches astonishing proportions. Further afield we encounter the same geographical features and social organization in the west of Scotland where the grazing committees still actively control the apportionment of grazing rights. In Wales, the *tref*, or *pentref*, has recently been shown, as a result of a regional study of the Teify valley similar to that on which we are

engaged, to underly the modern housing pattern, and the *tref* seems to be the clachan with another name. Traces could no doubt be found in other places, such as the west country of England.

Below the 500-foot contour, in the area of single farmsteads, few traces of the clachans survive. The folk-tales and the place-names give occasional clues, and with a very intensive study of farm types we might reconstruct the geography of settlement in the preceding centuries. Along the Braid itself another form of house cluster is noticeable. In a farming community shops and periodical fairs are essential. Many Irish fairs are held in open country and the shops may be booths set up for the day, but generally a fair means a village. The Braid valley has only two villages. One, Buckna, is a tiny place with less than fifty inhabited houses. Situated on a ford across a tributary stream, it has a few shops, a church, a school, and a couple of flax-scutching mills. However, the main road along the valley from east to west now passes it by on the opposite bank of the Braid, and we can see a new nucleus springing up at the crossroads near the head of the valley, the Sheddings. This has also a shop or two and the sheep fairs are now held nearby.

Where the major right-bank tributary joins the Braid at a point where the main stream was formerly fordable, on the junction of an old north-south trackway with the modern valley-bottom road, stands the more important village of Broughshane. The 'town of Shane' may already have been there when St. Patrick came back to christianize his former owner, Milchu, whose fifth-century farmstead is reputed to have stood at Skerry, a few miles away. Tradition says the villagers did not assist him and that he cursed the place, saying it would

never grow any bigger. The settlement *has* grown in recent years but the reason is not to be found in the agricultural lands upstream. Half a mile away is a relatively modern factory building. It now turns out woollen cloth of special weaves for exclusive suitings in London, New York, and other centres of modern civilization. By specializing on high-quality cloths and producing for an economic level that can afford to pay for exclusive designs, it survives in face of the woollen mills of Yorkshire because in effect it is not in competition with them. Broughshane has two or three churches of different religious groups, eleven shops, three craftsmen, and a population of some 500 adults. Rather more than a quarter of these are employed in the local factory, and the rest of the workers are drawn from houses scattered among the farmers and labourers in the surrounding countryside.

At the lowest crossing point before the Braid meanders across the waterlogged floodplain to join the River Main has grown up the market town. Dominating the ford from a high bluff, a glacial sandbank, is an earthen castle mound built by the Anglo-Normans in the attempt to overrun Ulster in the first years of the thirteenth century. The modern town owes little to this first building; it has been built on the opposite bank of the river. Ballymena grew during the eighteenth and nineteenth centuries as an agricultural market and more importantly as a market for hand-woven linen cloth. To-day it has two large linen factories, a population of 13,527 (estimate for 1947), and it is the principal market centre for the agricultural produce of mid-Antrim. The market radius is shown in fig. 18. We need not count the shops; the difference in population as compared with

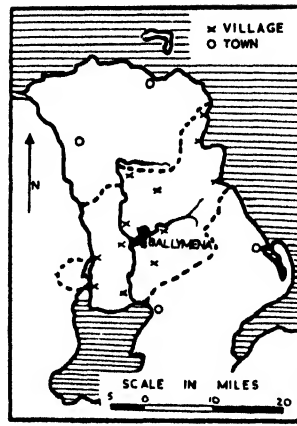

Fig. 18. MARKET AREA OF BALLYMENA.

Broughshane is sufficient to show that we have reached a new category of agglomeration. In the town are concentrated professional and entertainment services for the whole of the market area. Lawyers, accountants, dentists, doctors, hospitals, secondary and technical schools, represent the professional world. Entertainment and information are provided by the two large cinemas, by the weekly newspaper, and we might also include in this category the numerous public houses which congregate most closely around the agricultural sale-yards. At Ballymena we encounter the railway and the main arterial road. Along these pass much of the produce of the countryside and of the factories to distant markets. Linen and woollen cloth for the making-up trade, livestock and livestock products for the city dwellers in Belfast, Glasgow, Liverpool, and beyond.

The market area from which these goods come and to which the town distributes groceries and machine-made goods of the outer world has already been mentioned. It is obvious from the diagram that the physical features of the countryside influence the market radius and that social factors, such as the presence of adjacent towns, also have a considerable effect.

Observation in the field reveals many other details. The older houses of round field stones and mud mortar, the roofs of thatch, the single-storey construction, and the layout of dwelling house and outbuildings on one side of a paved passage, known locally as the 'street', are signs of the subsistence agriculture days before the modern market economy affected the valley. They are typical too of construction in a country where wood was not plentiful, for stone is always more difficult to handle than wood. The scattered houses show that underground water was easily reached by shallow wells at any point in the landscape. Without this possibility houses would have had to cluster together but, of course, the mere fact of easy water-supply did not *compel* the scattering of the farmsteads, it only permitted its attainment if the community chose this type of settlement.

We have already referred to the clachans which as a form of settlement are older than even the oldest single-storey houses. The disappearance of the domestic linen weavers and their small plots of flax and potatoes after the establishment of factories in Ballymena and Broughshane, permitted the concentration of all the energies of the landholders on farming. By decreasing the number of people in the valley it also allowed the average size of farm to be increased from about 15 acres in 1860 to about 30 acres in 1940. Phases of agricultural prosperity from the last quarter of the nineteenth century to the present day are clearly reflected in the newer house types. Two-storey styles with slated roofs, local copies in stone or brick of urban styles, creep in and the older dwellings become out-houses. These contrasting house types are particularly noticeable in the villages and in Ballymena.

A study of a local area is a valuable educational technique. The relationships of the physical facts that shape the countryside, the solid geology, land-sculpturing forces, soils, and climate with the ways of life of the inhabitants can be demonstrated. In discussions of settlement, land use, marketing, and factory industry the position of the area in relationship to historical movements and to modern transport and city life must be considered. Thus in the Braid we referred to the Scots accent, a reminder of the settlement of the Presbyterian Scots three hundred years ago and the subsistence farming and domestic weaving that preceded the factories and production for the British market. No people arrive in a district without a past history which influences their approach to the landscape, and no people live without having contacts with neighbours who influence them in many subtle ways. The field-worker has to use his training in geographical techniques to interpret a dynamic entity, and this analysis and reintegration will test his ability to see what is there in reality and to present the complexity of geographical relationships in their true perspective.

One of the major functions of geography is to direct attention to the interrelationships of phenomena affecting the surface of the earth, not omitting man. Into this age of specialized inquiry, of studying details for their own sake, it brings the valuable corrective of not dividing what nature has put together. It links together the arts and the sciences, and in years to come its technique will be more valuable as the social sciences devise methods of measuring inter-human relations as detailed and as fitted to their purpose as those

of the physical sciences. A geographical training even in the study of a small area soon develops a rational approach to the problems of other regions and a tolerant appreciation of the outlook of other peoples.

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IT is particularly difficult to prepare a reading list in geography, for the subject covers a wide field and the facts on which geographers base their generalizations come from many sciences. Two good atlases may be recommended at the outset, *The Oxford Advanced Atlas*, compiled by John Bartholomew, and *The University Atlas*, by Goodall and Darby. In addition, for the location of places reference should be made to *The Times Atlas of the World*. The preparation of maps for such atlases as these and for other specialized purposes is best dealt with by J. A. Steers in *An Introduction to the Study of Map Projections* (5th ed., 1949). A more difficult work, requiring a knowledge of calculus, is A. R. Hinks, *Map Projections* (1921). A fascinating account of methods by which a student can make his own maps of small areas is given in *Map Making* (1936) by F. Debenham. A readable short history of maps and their development from antiquity to the present day will be found in I. J. Curnow, *The World Mapped* (1930). As the history of maps is closely allied to the history of geography the serious student may wish to tackle the three-volume work by C. R. Beazley, *The Dawn of Modern Geography* (1897, 1901 and 1906). A shorter account of the same topic is *The Making of Geography*, by R. E. Dickinson and O. J. R. Howarth (1933). Written from a different viewpoint and packed with information on early travellers is J. N. L. Baker's *History of Geographical Discovery and Exploration* (1937).

The Physical Basis of Geography, by S. W. Wooldridge

and R. S. Morgan (1937), deals with the continents, land forms, and the cycle of erosion in a masterly fashion. From the geologist's viewpoint the companion work in the present series, *Geology*, by H. H. Read (1949), should not be overlooked. The form of the continents and the process of mountain building is discussed in J. Joly's *Surface History of the Earth* (1930). The climatic factor is treated geographically by W. G. Kendrew in *The Climates of the Continents* (1937) and by A. A. Miller in *Climatology* (1931). There is a vast literature on these fields and most of the books contain references for further reading. For those who read French E. de Martonne's *Traité de Géographie Physique* (3 vols., 1925–9) covers in a lucid style both the physical aspects of geography and the plant and animal cover of the earth.

The environmental control of human activities has been the theme of several books by T. Griffith Taylor, of which we may list *Environment and Nation* (1936). The classical account of the viewpoint of this school is E. C. Semple's *Influence of the Geographical Environment* (1911). Out of the welter of writings on the influence of the climatic factor on human affairs we may mention the numerous books of Ellsworth Huntingdon from *The Pulse of Asia* (1909) to *Mainsprings of Civilisation* (1945). The importance of man and of human culture in relation to the landscape has been emphasized by many French geographers. It is impossible not to refer to the master of the subject, Paul Vidal de la Blache, whose *Principles of Human Geography* written in the years before 1918 is available in an English translation dated 1926, and to J. Brunhes's *Human Geography* (1920), also in an English version. The magnificent undertaking of a regional treatment of the world in the 15 volumes of

Géographie Universelle (1927–39) has maintained a high standard of accuracy and expression throughout. Before passing to other departments a fascinating book by C. D. Forde, *Habitat, Economy and Society* (1934) must be recommended.

The source book for economic geography is the *Handbook of Commerical Geography*, by G. G. Chisholm, kept up to date by successive editions. Most regional geographies, available in libraries as they are the standard works, include a treatment of the economic geography of their area. We may select for inclusion here *The British Isles*, by L. D. Stamp and S. H. Beaver, which again has passed through several editions since 1933. An older, but still valuable, description of the same area from a different viewpoint is *Britain and the British Seas*, by H. J. Mackinder (1902).

Politics and geography have had much to suffer at the hands of hasty thinkers. Leaving aside the German writers, we select the following four texts as level and sensible even when they are concerned to argue a belief: H. J. Mackinder, *Democratic Ideals and Reality* (1919, but re-issued in Pelican Books, 1944); J. Fairgrieve, *Geography and World Power* (1920); C. B. Fawcett, *Political Geography of the British Empire* (1933); D. Whittlesey, *The Earth and the State* (1944). A briefer, but equally sound, study is H. J. Fleure's *Geographical Background to World Problems* (1932).

For the technique of field-study reference should be made to C. C. Fagg and G. E. Hutchings, *Regional Surveying* (1930), or to the publications of the Le Play Society. Background information on the local study in this book may be culled from E. E. Evans's *Irish Heritage* (1942) or J. M. Mogey's *Rural Life in Northern Ireland* (1947).

Two final recommendations should be added to the books listed. First, no geographer should neglect good travel literature such as Mary H. Kingsley, *Travels in West Africa* (1897), the travels of Marco Polo and other historical figures, or C. M. Doughty's classic *Travels in Arabia Deserta* (1928). Local librarians will help inquirers to sift the wheat from the chaff. Even a good novel with a regional background should not be despised. The second reminder is to refer constantly to the current publications for geographers, and if possible to subscribe to one of them. The most important periodicals, in order of first appearing, are: *The Scottish Geographical Magazine* (1885—), *The Geographical Journal* (1893—), *La Géographie* (1900—), *Geography* (1901—), *The Geographical Review* (1916—) and *Economic Geography* (1925—). All contain book reviews and articles which usually make reference to the best authorities in geography.

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